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METHODOLOGY FOR THE DETERMINATION OF EMISSION LINE SOURCES

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METHODOLOGY FOR THE DETERMINATION OF EMISSION LINE SOURCES

by

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ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Waste Management
Office of Air Quality Planning and Standards
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16. ABSTRACT

The study of automotive vehicle pollution in a metropolitan area requires accurate reporting of emissions. This depends on efficient monitoring of traffic flow, and knowing the location parameters critical to the emission process, and adequate knowledge of vehicular emissions under a range of operating conditions.

This report describes the development of a methodology which documents the criteria for determining which major freeway and arterial links should be considered emission line sources in a metropolitan area. In addition to developing the methodology, it is used in the St. Louis Air Quality Control Region, to determine specifically what links shall be considered as line sources.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Line Source Emissions Emissions SAPOLLUT CO NO_x HC		

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TABLE OF CONTENTS

Page

CHAPTER I - INTRODUCTION - STUDY DESIGN - - - - - - - - - - - - - - - 1
- A.) Introduction - Objectives of Research - - - - - - - - - - 1
- B.) Limited Literature Search - - - - - - - - - - - - - - - - - 2
  - 1.) Relevance of Air Standards - - - - - - - - - - - - 2
  - 2.) Relationships of Emissions to Key Traffic Engineering Stimuli - - - - - - - - 3
- C.) Formal Research Plan - - - - - - - - - - - - - - - - - - 12
  - 1.) Emissions Related Traffic Flow Research Aspects - 12
  - 2.) Specific Work Plan of Research - - - - - - - - - - 15

CHAPTER II - DATA DEVELOPMENT - 22

CHAPTER III - MODEL DEVELOPMENT - - - - - - - - - - - - - - - - - - - 27
- A.) Overview of Model Logic - - - - - - - - - - - - - - - - - 27
- B.) Software System Development - - - - - - - - - - - - - - - 33

CHAPTER IV - DOCUMENTATION OF EMISSION LINE SOURCES - - - - - - - - 40
- A.) Introduction - Issues in Defining Line Sources - - - - 40
- B.) Basic Definitions - Delineation of Gross Line Sources - 40
- C.) Refined Level - Ultimate Definition of Line Sources - - 49
- D.) Synthesis of Line Source Information- - - - - - - - - - - 63
- E.) Related Processing Costs - - - - - - - - - - - - - - - - - 75
- F.) Limited Sensitivity Analysis - - - - - - - - - - - - - - - 78

CHAPTER V - CONCLUSION - 87
- A.) Use and Applicability of Present Research and Modelling Results - - - - - - - - - - - - - - - - - - 87
- B.) Recommendations for Further Research - - - - - - - - - - 88
- C.) Closing Comments on Status of Line Source-Traffic Attribute Modelling - - - - - - - - - - - - 91

(Continued)

TABLE OF CONTENTS (Continued)

Page

BIBLIOGRAPHY - 93

Selected Research Bibliography - - - - - - - - - - - - - - - - - 94

St. Louis Area Traffic Data Sources - - - - - - - - - - - - - - - 95

Professional Interviews - 96

APPENDIX A - COMPUTER PROGRAM DOCUMENTATION - - - - - - - - - - - - 97

A-1 NETSEN Program - 98

A-2 HRCVRT Program - 123

A-3 Data Management Program - - - - - - - - - - - - - - - - - - - 133

A-4 Interface Program - 137

APPENDIX B - EXAMPLES OF DATA COLLECTION AND CODING FORMAT - - - - 143

LIST OF TABLES

Page

TABLE 1 - ADT RANGES USED FOR GROSS LEVEL LINE SOURCE DEFINITION - - - - - - - - - - - - - - - - - 42

TABLE 2 - GROSS LEVEL LINE SOURCE EMISSIONS (FUNCTIONAL CLASS-FREEWAYS) - - - - - - - - - - - 44

TABLE 3 - GROSS LEVEL LINE SOURCE EMISSIONS (FUNCTIONAL CLASS-PRINCIPAL ARTERIALS) - - - - 46

TABLE 4 - GROSS LEVEL LINE SOURCE EMISSIONS (FUNCTIONAL CLASS-MINOR ARTERIALS) - - - - - - 48

TABLE 5 - ADT RANGES USED FOR ULTIMATE LINE SOURCE DEFINITION - - 51

TABLE 6 - ULTIMATE LINE SOURCE EMISSIONS (FUNCTIONAL CLASS-FREEWAYS) - - - - - - - - - - - 53

TABLE 7 - ULTIMATE LINE SOURCE EMISSIONS (FUNCTIONAL CLASS-FREEWAYS) - - - - - - - - - - - 55

TABLE 8 - ULTIMATE LINE SOURCE EMISSIONS (FUNCTIONAL CLASS-FREEWAYS) - - - - - - - - - - - 57

TABLE 9 - ULTIMATE LINE SOURCE EMISSIONS (FUNCTIONAL CLASS-FREEWAYS) - - - - - - - - - - - 59

TABLE 10 - ULTIMATE LINE SOURCE EMISSIONS (FUNCTIONAL CLASS-PRINCIPAL ARTERIALS) - - - - 61

TABLE 11 - ULTIMATE LINE SOURCE EMISSIONS (FUNCTIONAL CLASS-PRINCIPAL ARTERIALS) - - - - 64

TABLE 12 - ULTIMATE LINE SOURCE EMISSIONS (FUNCTIONAL CLASS-PRINCIPAL ARTERIALS) - - - - 66

TABLE 13 - ULTIMATE LINE SOURCE EMISSIONS (FUNCTIONAL CLASS-PRINCIPAL ARTERIALS) - - - - 68

TABLE 14 - ULTIMATE LINE SOURCE EMISSIONS (FUNCTIONAL CLASS-MINOR ARTERIALS) - - - - - - 70

TABLE 15 - ULTIMATE LINE SOURCE EMISSIONS (FUNCTIONAL CLASS-MINOR ARTERIALS) - - - - - - 72

TABLE 16 - ULTIMATE LINE SOURCE EMISSIONS (FUNCTIONAL CLASS-MINOR ARTERIALS) - - - - - - 74

(Continued)

LIST OF TABLES (Continued)

Page

TABLE 17 - SUMMARY OF ULTIMATE LINE SOURCE EMISSIONS INFORMATION - 76

TABLE 18 - PERCENTAGE OF TOTAL EMISSIONS CONTRIBUTED BY FUNCTIONAL CLASS OF LINE SOURCE - - - - - - - - - 77

TABLE 19 - COST SUMMARY FOR TYPICAL SOFTWARE SYSTEM RUN - - - - - - 79

TABLE 20 - EMISSIONS SUMMARY FOR FREEWAY CORRIDOR DIVERSION - - - 82

TABLE 21 - EMISSIONS SUMMARY FOR PARALLEL ARTERIAL DIVERSION - - - 85

LIST OF FIGURES

Page

FIGURE 1. Speed Correction Factors for 1968 Model Year Vehicles in Low Altitudes - - - - - - - - - - - - 4

FIGURE 2. Speed Correction Factors for 1968 Model Year Vehicles in Denver- - - - - - - - - - - - - - - - 5

FIGURE 3. Speed Correction Factors for 1971 Model Year Vehicles in Denver- - - - - - - - - - - - - - - - 6

FIGURE 4. Pollution Levels Along Transverse Street Cross Section of Centered Expressway with Joint Development Structures - - - - - - - - - - - - - - 8

FIGURE 5. Pollution Levels Along Transverse Street Cross Section of Centered Expressway without Joint Development Structures - - - - - - - - - - - - - - 9

FIGURE 6. Pollution Levels Along Transverse Street Cross Section of Centered Expressway-Boulevard - - - - - - - - 10

FIGURE 7. Comparison of City Street and Freeway Conditions - - - 11

FIGURE 8. Flow Parameters Related to Emissions and/or Air Quality Phenomena - - - - - - - - - - - - - 16

FIGURE 9. Research Work Plan - 17

FIGURE 10. Master Logic of NETSEN Model - - - - - - - - - - - - - - - 28

FIGURE 11. Traffic Emissions Software System - - - - - - - - - - - - 34

FIGURE 12. Gross Level Line Sources (Functional Class-Freeways) - 43

FIGURE 13. Gross Level Line Sources (Functional Class-Principal Arterials) - - - - - - - - - - - - - - - 45

FIGURE 14. Gross Level Line Sources (Functional Class-Minor Arterials) - - - - - - - - - - - - - - - - - 47

FIGURE 15. Ultimate Line Sources (Functional Class-Freeways) - - 52

FIGURE 16. Ultimate Line Sources (Functional Class-Freeways) - - 54

FIGURE 17. Ultimate Line Sources (Functional Class-Freeways) - - 56

FIGURE 18. Ultimate Line Sources (Functional Class-Freeways) - - 58

(Continued)

LIST OF FIGURES (Continued)

Page

FIGURE 19. Ultimate Line Sources (Functional Class-Principal Arterials) - - - - - - - - - - - - - - 60

FIGURE 20. Ultimate Line Sources (Functional Class-Principal Arterials) - - - - - - - - - - - - - - 62

FIGURE 21. Ultimate Line Sources (Functional Class-Principal Arterials) - - - - - - - - - - - - - - 65

FIGURE 22. Ultimate Line Sources (Functional Class-Principal Arterials) - - - - - - - - - - - - - - 67

FIGURE 23. Ultimate Line Sources (Functional Class-Minor Arterials) - - - - - - - - - - - - - - - - 69

FIGURE 24. Ultimate Line Sources (Functional Class-Minor Arterials) - - - - - - - - - - - - - - - - 71

FIGURE 25. Ultimate Line Sources (Functional Class-Minor Arterials) - - - - - - - - - - - - - - - - 73

FIGURE 26. Emissions Summary for Freeway Corridor Diversion - - - 81

FIGURE 27. Emissions Summary for Parallel Arterial Diversion - - 84

FIGURE A-1 Program GIN Flowchart - - - - - - - - - - - - - - - - - - 136

FIGURE A-2 Program RUMMY Flowchart - - - - - - - - - - - - - - - - 138

CHAPTER I

INTRODUCTION - STUDY DESIGN

A. INTRODUCTION - OBJECTIVES OF RESEARCH

The study of pollution concentrations in a metropolitan area requires accurate characterization of pollution emitted due to the presence and operation of transportation corridors and grids, termed line sources. Accurate reporting of emissions depends on efficient monitoring of traffic flow and system design and location parameters critical to the emission process, in addition to adequate characterization of vehicular emissions under a range of operating conditions.

The objective of this research is to develop a methodology which documents the bases and criteria for determining which major freeway and arterial links should be considered emission line sources in a metropolitan area, and their geographic and temporal sensitivity to frequency and duration of monitoring. In addition to developing the methodology, it is to be verified through testing in the St. Louis Air Quality Control Region, determining specifically what links in this region shall be considered as line sources. In accomplishing the above, several specific performance objectives will be attained, which are:

a.) Obtainment and documentation of the most recent traffic data relevant to emissions phenomena for the St. Louis Region.

b.) Development of the methodology, and use of the above data to estimate emissions levels, through the use of the Department of Transportation model SAPOLLUT, which computes aggregate emissions and concentrations of CO, NO_x and HC for a traffic network. Detailed discussion of the model operation as used in this research is found in Chapters III, IV and Appendix A.

c.) Additional conceptualization of the methodology to formulate a sensitivity analysis which analyzes emissions information provided by different combinations of line source components, and allows comparison of information output vs. different specifications of traffic network inputs.

d.) Verification of the sensitivity analysis on the St. Louis Area, ultimately yielding appropriate specifications of emission line sources in the area.

B. LIMITED LITERATURE SEARCH

The objective of a limited literature search into traffic behavior and air pollution emissions in a project such as this one is to reinforce basic knowledge of relationships of emissions to key traffic behavioral variables. In so doing, the search allows the research team to see the rationale for their model building, its particular relationship to emissions stimuli, and to develop an overview and fluency with the traffic engineering literature dealing with the problem.

1.) Relevance of Air Standards

A basic research program with such a broad and intensive scope as the RAPS program is interested in accurately uncovering the phenomena of behavior of line sources and their resultant emissions, and the part these emissions play in the region-wide emissions problem. In so doing, the capability exists to add to basic knowledge which may ultimately lead to improved strategies for meeting ambient air standards.[1]

The highway system acting as a line source may act as a primary cause of CO. It may be a contributor to NO_x and HC emissions. Certain aspects of the highway transportation system will now be investigated in relation to these.

2.) Relationships of Emissions to Key Traffic Engineering Stimuli

The pollutants of CO, HC and NO_x have documented associations with speed.[2] Results of recent research on such associations is graphically shown in Figures 1, 2, and 3. These figures are the result of developed equations of:

$$LN\ HC = A + B\overline{S} + C\overline{S}^2 \text{ in grams/mile}$$

$$LN\ CO = A' + B'\overline{S} + C'\overline{S}^2 \text{ in grams/mile}$$

$$NO_x = A'' + B''\overline{S} \text{ in grams/mile}$$

In the above, $\overline{S}$ is the average speed of the driving sequence. To determine the speed correction factor at any particular speed in the range of 15 to 45 miles per hour, a ratic of the above equations is used. The emissions are determined at the desired speed and ratioed with the emissions at a speed of 19.6 miles per hour, the average speed over the federal driving schedule.[3] Figure 1 represents vehicle model year 1968 in low altitudes, Figure 2 represents the 1968 vehicle model year in Denver, and Figure 3 represents the 1971 model year in Denver. It should be noted the relationship is quadratic with respect to HC and CO, and linear with respect to NO_x, yielding decreasing emissions with increased average route speed for HC and CO, and increasing emissions of NO_x with increased average route speeds.

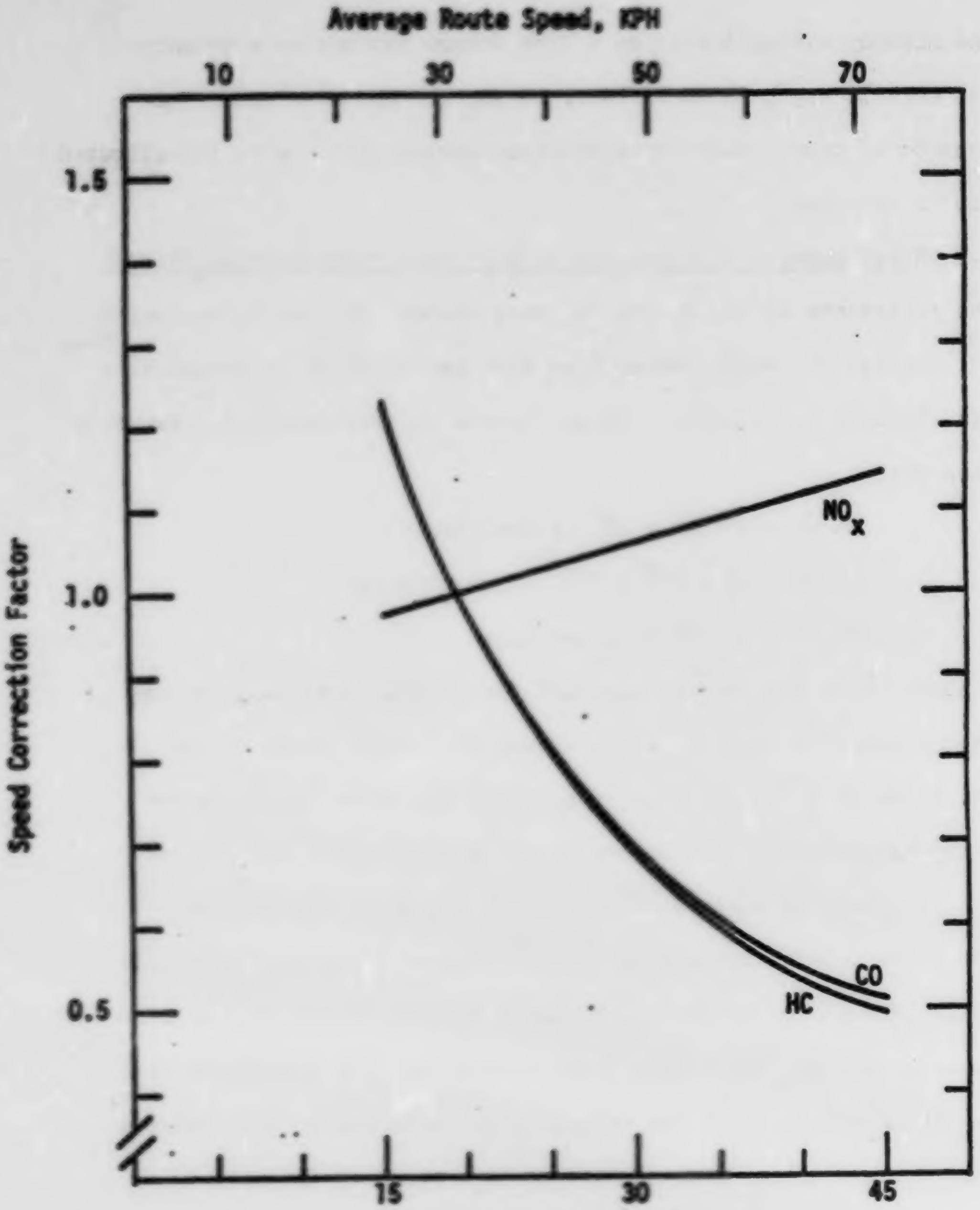


FIGURE 1. Speed Correction Factors for
1968 Model Year Vehicles in Low Altitudes

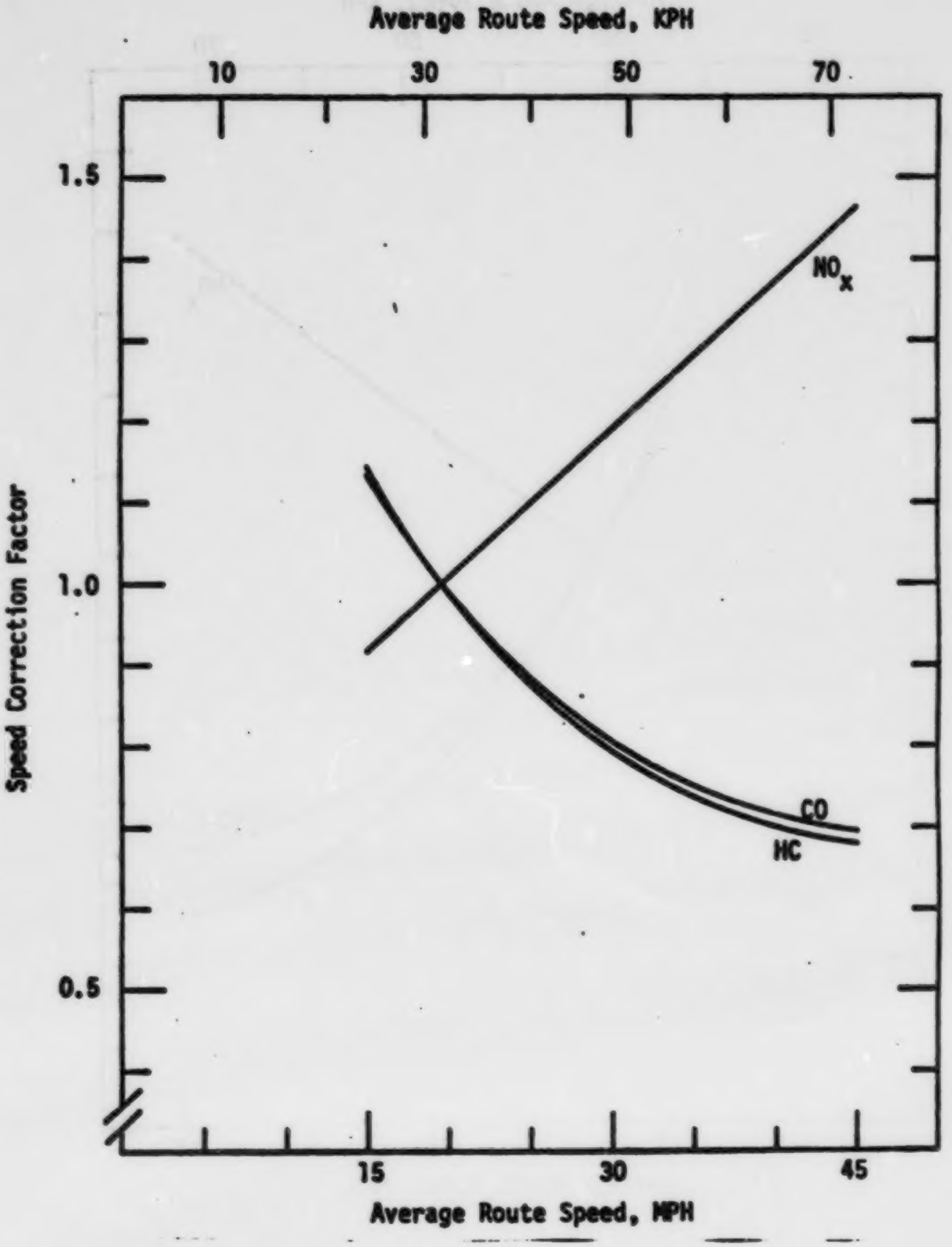


FIGURE 2. Speed Correction Factors for 1968 Model Year Vehicles in Denver

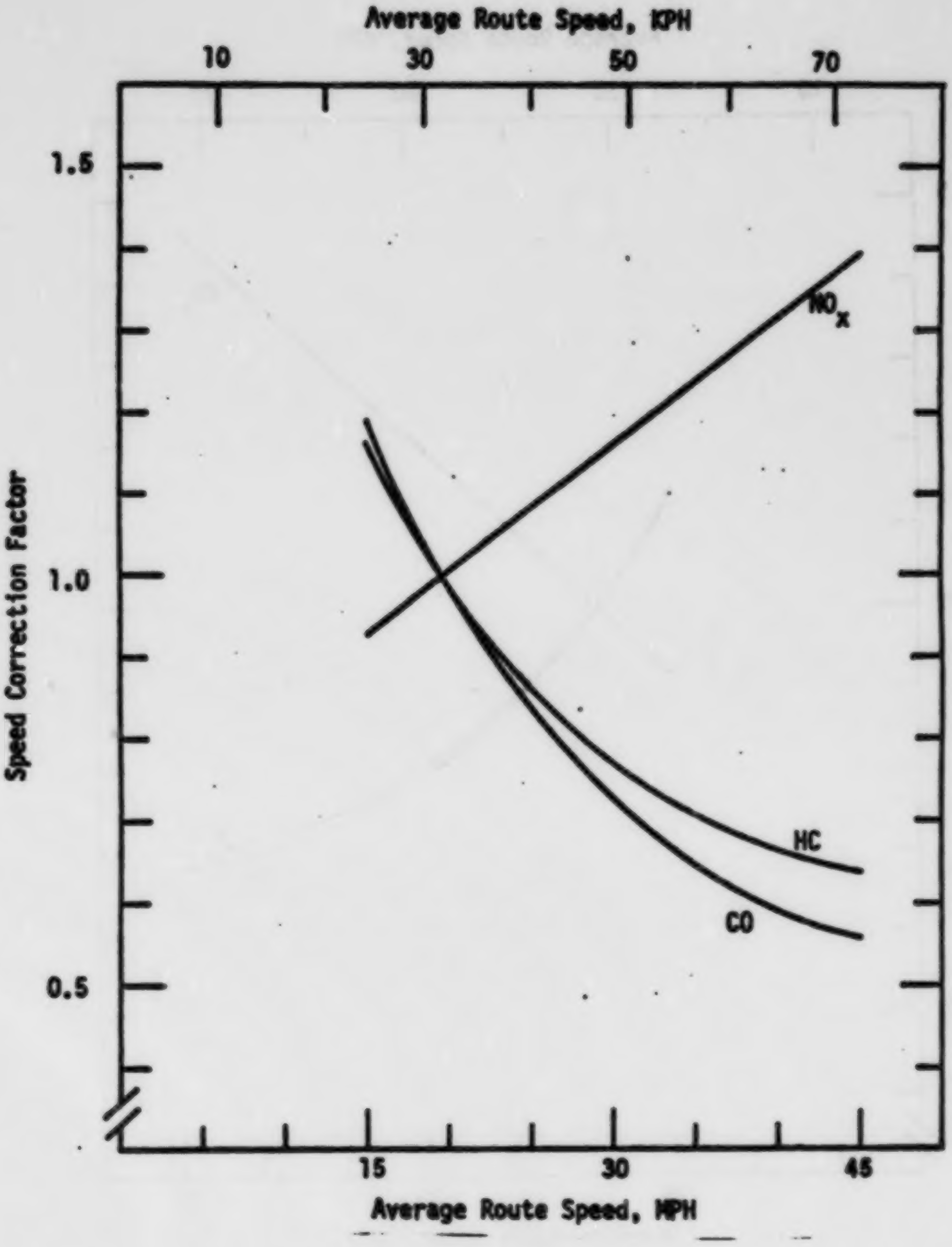


FIGURE 3. Speed Correction Factors for
1971 Model Year Vehicles in Denver

A further finding is that complex highway design configurations, unique localized meterology, presence of topography and rough terrain and downtown or high-rise street canyons play readily identifiable, but relatively less understood roles in air quality. In the simplest sense, average speed and vehicle miles of travel on a link are relevant inputs as indicators of CO, HC and NO_x emissions. The realistic design, environmental and neighborhood attributes modify the impact of these two basic stimuli on air quality, and the mechanics of these modifications are not developed in depth in the basic research to date. Figures 4, 5 and 6 are offered as visual examples of research output of the effect of geometric configuration on air quality.[4] A further behavioral input, closely related to average speed, is the smoothness of traffic flow and capability of avoiding traffic congestion effects. Figure 7 shows the concentrations for smooth, uninterrupted flow of 30 mph of typical freeway movement versus higher emissions induced by poor signal timing, pedestrian and parking interference which increases delay on a typical interrupted flow arterial street operating poorly.[5] As such, from a traffic engineering point of view, V/C ratios and acceleration noise parameters of the traffic stream are relevant to emissions levels.

In conclusion, the literature search revealed:

1.) The basic stimuli of emissions to be wel documented against inputs of average speed and VMT for CO and HC, with more questionable data and relationships with respect to NO_x.

2.) Further complexities in air quality overlaid on the above when cut, fill, and complex cross section and geometric design configurations are included, as illustrated in Figures 4, 5 and 6.

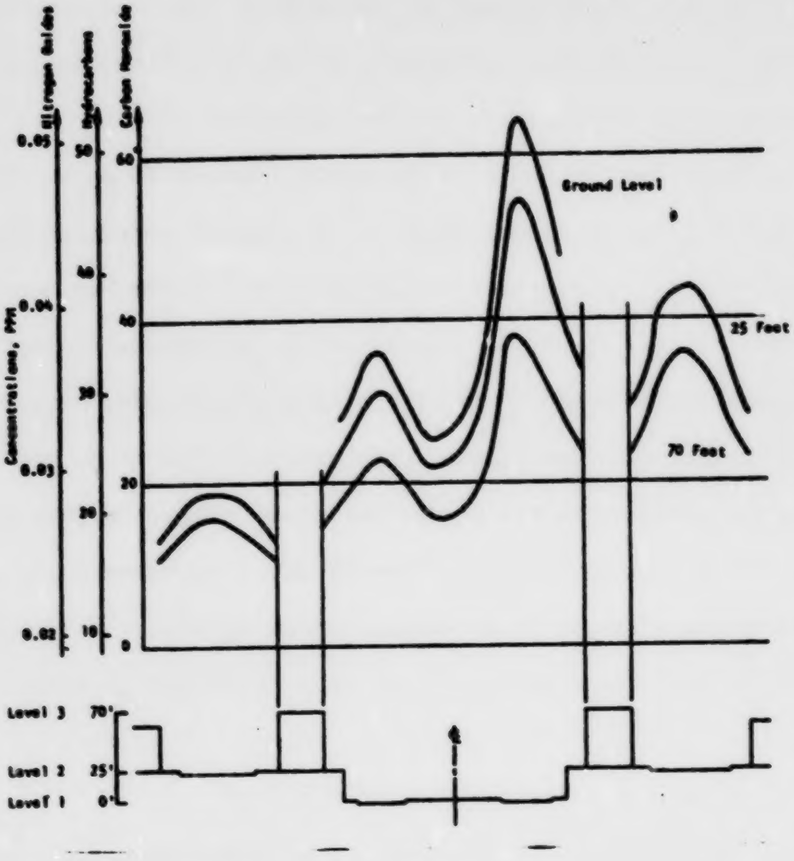


FIGURE 4. Pollution Levels Along Transverse Street Cross Section of Centered Expressway with Joint Development Structures

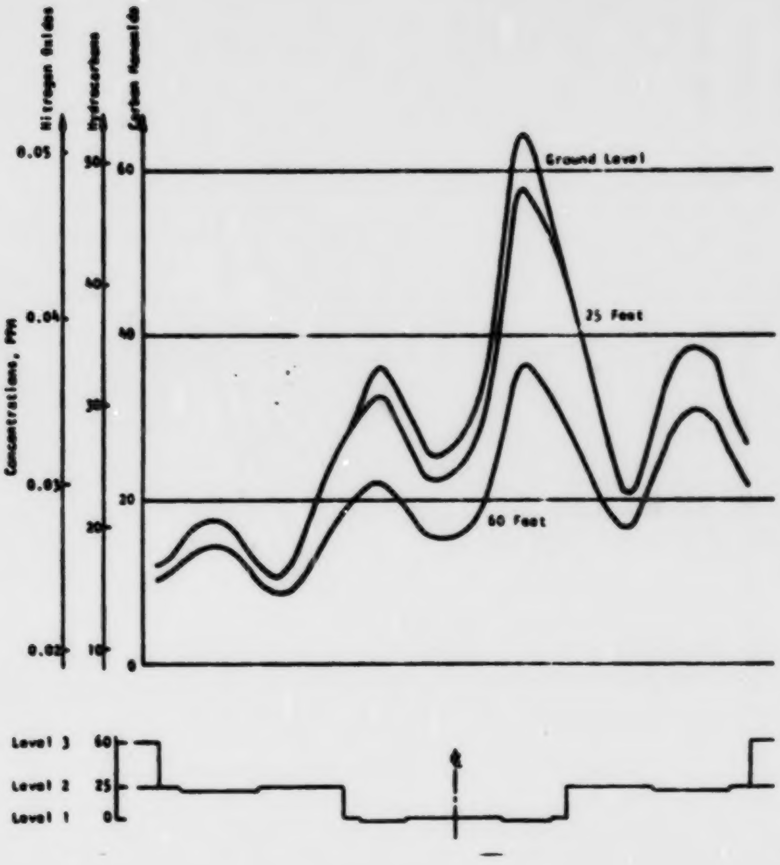


FIGURE 5. Pollution Levels Along Transverse Street Cross Section of Centered Expressway Without Joint Development Structures

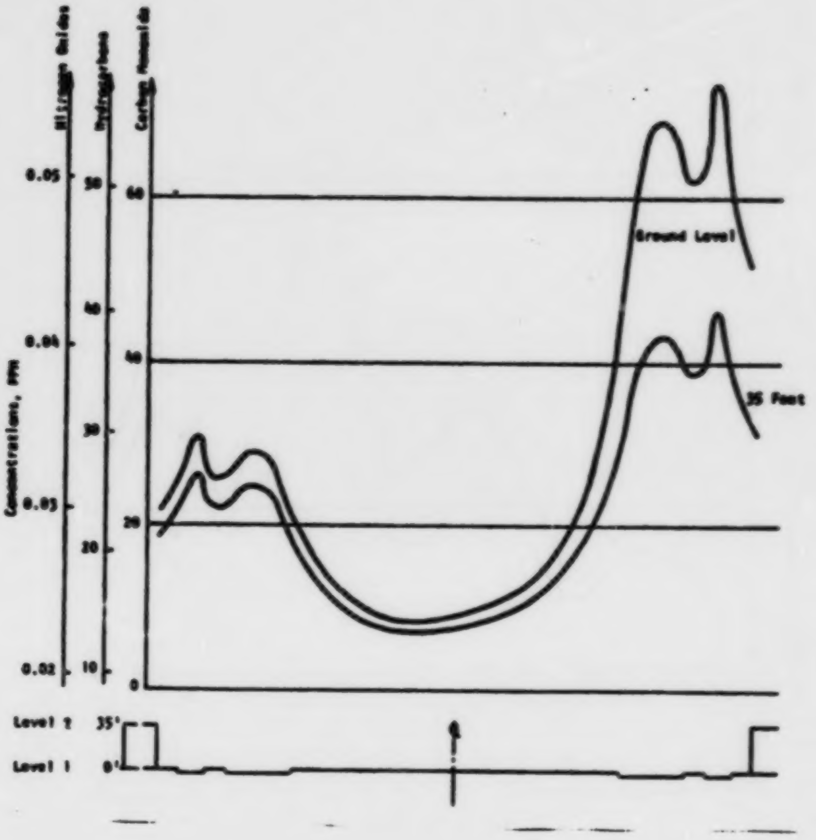


FIGURE 6. Pollution Levels Along Transverse Street Cross Section of Centered Expressway-Boulevard

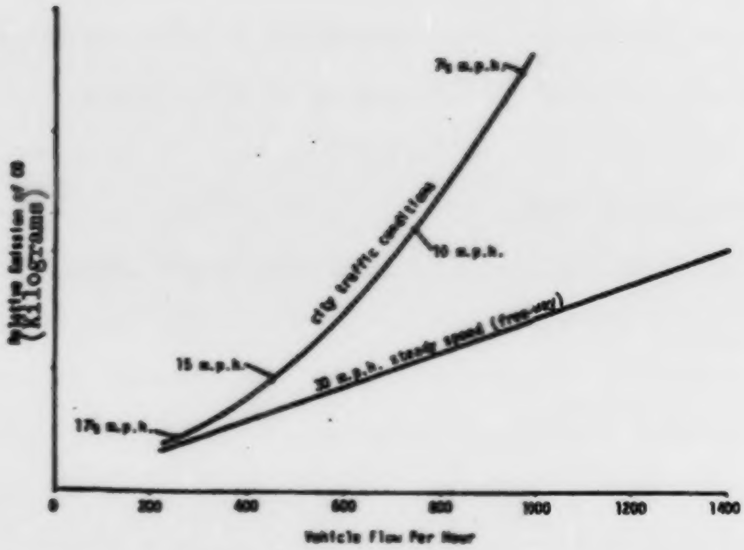


FIGURE 7. Comparison of City Street and Freeway Conditions

3.) Further complexity in emissions when system delay from congestion is introduced, as illustrated in Figure 7.

4.) Further complexity in air quality when overlaid by local, uniquely complex topography and terrain, and localized unique meterologic conditions.

5.) The apparent need for further basic research on line sources where such complexities in 2-4 above are introduced. That is, further research into locating them, stratifying their attributes, classifying them in an orderly data system, and relating their attributes to their resulting link emissions and the air quality of their locale.

C. FORMAL RESEARCH WORK PLAN

1.) Emissions and Air Quality-Related Traffic Flow Research Aspects

In light of the previous literature search, it has been categorically found that volume, or vehicle miles of travel, and average speed are critical inputs which relate to emissions of nitrogen oxides, carbon monoxides and hydrocarbons. However, exhaustive use of typical traffic flow data related to the above two inputs should allow a refined and meaningful statement of flow phenomena and traffic systems design which pollution output is sensitive to. Thus, a short discussion of such flow-related parameters is warranted, to demonstrate their categorization as inputs:

Volumes - Average Daily Traffic and peak hour volumes, historically as indicators of use of the facility.

Average Travel Speed - As an indicator of efficiency of the facility and adequacy of design.

General Interzonal Origin-Destination Patterns - As a regional mapping of incidence of travel, and proximity of travel paths to other regional activities.

Functional Classification of Highways - Classed as whether freeway, arterial, collector or local, as an indication of importance and frequency of use and level of design standards employed.

Delay Information - which modifies or refines information on average speed, above, through studies of volume to capacity ratios, travel time profiles, travel time contours, or waiting time or delay contours. Locations are detected in the system where speeds are radically altered due to delay and congestion.

Locations of Design Related Phenomena - such as extremely complicated route or interchange configurations, and areas of cut or fill, or frontage roads with structures, which induce localized alterations in air quality and emissions, the latter when average speed is modified due to the design phenomena.

Unique Areas of Progression - in addition to areas which can be reviewed from speed and delay information as stated above, these are unique in the network, in that some engineering or planning alteration exists to eliminate congestion by specific means with highly predictable results, such as one-way street flows, or progressive signalization, thus allowing atypical consistency in volumes or average speeds, with stable emissions output.

Areas of Critical Land Use Adjacent to or Within the Network - The first type is an area adjacent to the traffic system which is a highly sensitive land use to emissions output and local air quality, or a land use type such as industrial, which supplements and confounds the emissions level and air quality in the vicinity of the corridor. The second type is the downtown or core area, or like areas of high-rise, high-density buildings. The building heights or "street canyons" affect air quality in the vicinity of the grid and corridor sources.

Vehicle Mix - the composition of traffic, in terms of percentage of autos, intermediate size trucks and large size trucks is relevant, due to differing emissions from vehicle type, and the impact of the traffic composition on average speed and traffic flow throughout a link. The composition of vehicles by age also determines the level of emissions from the traffic stream.

Frequency of Monitoring - all links under study will encompass some or many of the above flow related phenomena which have an impact on emissions and/or air quality. The frequency of observing such network components with respect to adequate characterization of CO, NO_x, and HC information is critical. Typical choices of duration of traffic volume counting periods include 1, 8, 12, 24 hours, weekly, and peak-off peak combinations.

Thus, the above considerations are relevant to comprehensively using traffic flow information to develop the "optimal" network inputs for specifying emissions line sources. Use of this information may be characterized by the following three dimensional array in Figure 8.

The research proceeds by essentially categorizing each apparently relevant link component with respect to the above array, then testing and trading off combinations of these with respect to emissions levels to ultimately produce a set of line sources. The process proceeds interactively, making full use of local traffic engineering knowledge about network components, yet developing the taxonomy in a rigorous and consistent logic.

2.) Specific Work Plan of Research

To accomplish the stated objectives, and develop the output discussed above, a six-phase work program has been pursued, as shown in Figure 9.

Phase 1 has four tasks, which were carried on simultaneously. Task 1.1 consisted of review of the flow aspects discussed above with respect to their impact on emissions. Tasks 1.2 and 1.3 included the procurement of St. Louis Air Quality Control Regional Traffic data, and review of important links and their traffic operating attributes (Figure 8) with local professionals. Through the principal investigator's local knowledge and contacts, use was made of East-West Gateway Regional Coordinating Council professionals, and engineers with Missouri State Highway Department, Illinois Department of Transportation, and St. Louis, St. Clair, Madison and other appropriate county engineering personnel. The results of 1.2 and 1.3 yielded realistic insights into the operation of corridors and arterial highway grid components. In Task 1.4, the traffic input and emissions output aspects of the model SAPOLLUT was reviewed, and the model was procured and put on the Washington University Software Library.

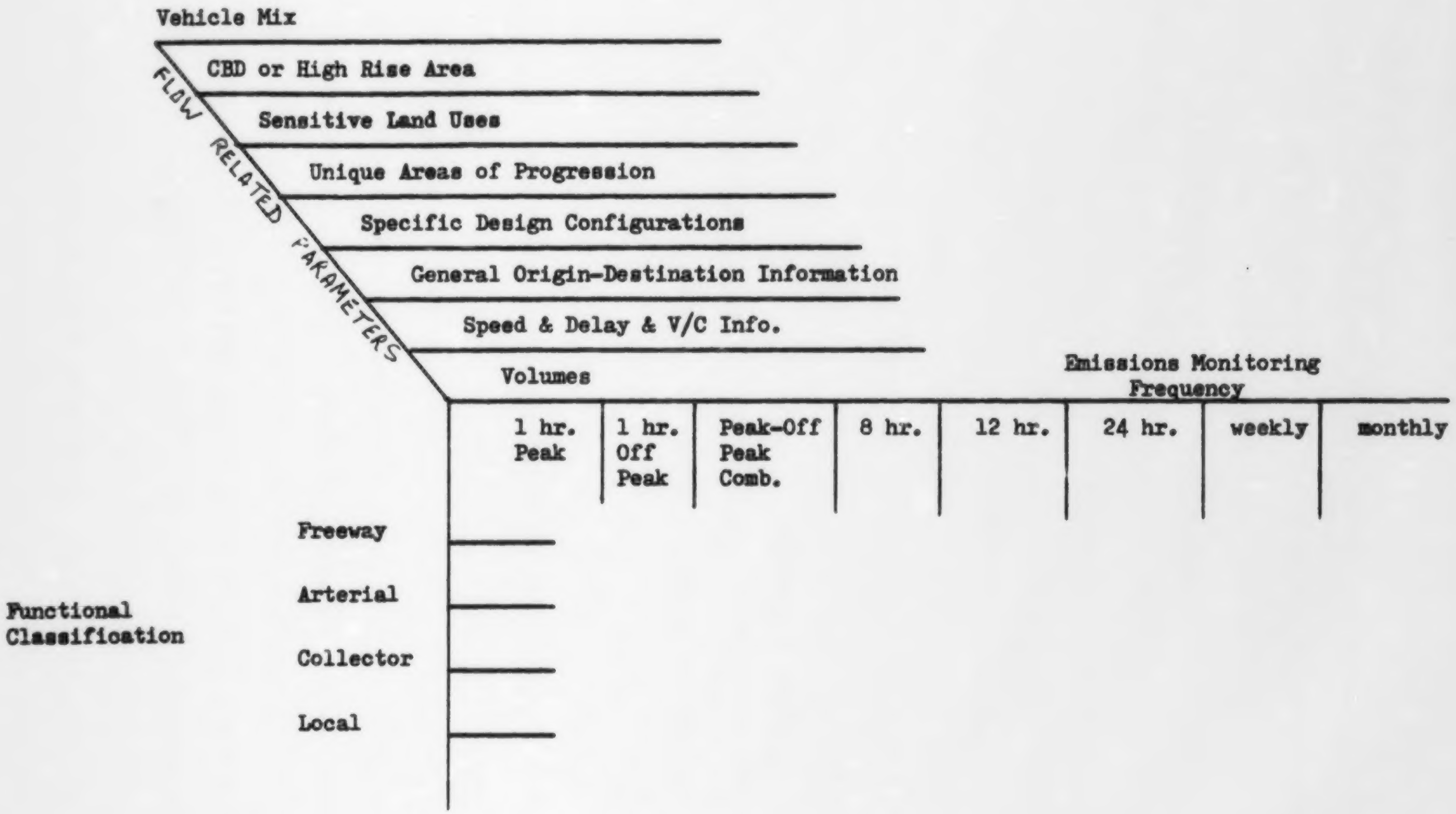

Vehicle Mix
CBD or High Rise Area
Sensitive Land Uses
Unique Areas of Progression
Specific Design Configurations
General Origin-Destination Information
Speed & Delay & V/C Info.
Volumes
FLOW RELATED PARAMETERS
Emissions Monitoring Frequency
1 hr. Peak
1 hr. Off Peak
Peak-Off Peak Comb.
8 hr.
12 hr.
24 hr.
weekly
monthly
Functional Classification
Freeway
Arterial
Collector
Local

FIGURE 8. Flow Parameters Related to Emissions and/or Air Quality Phenomena

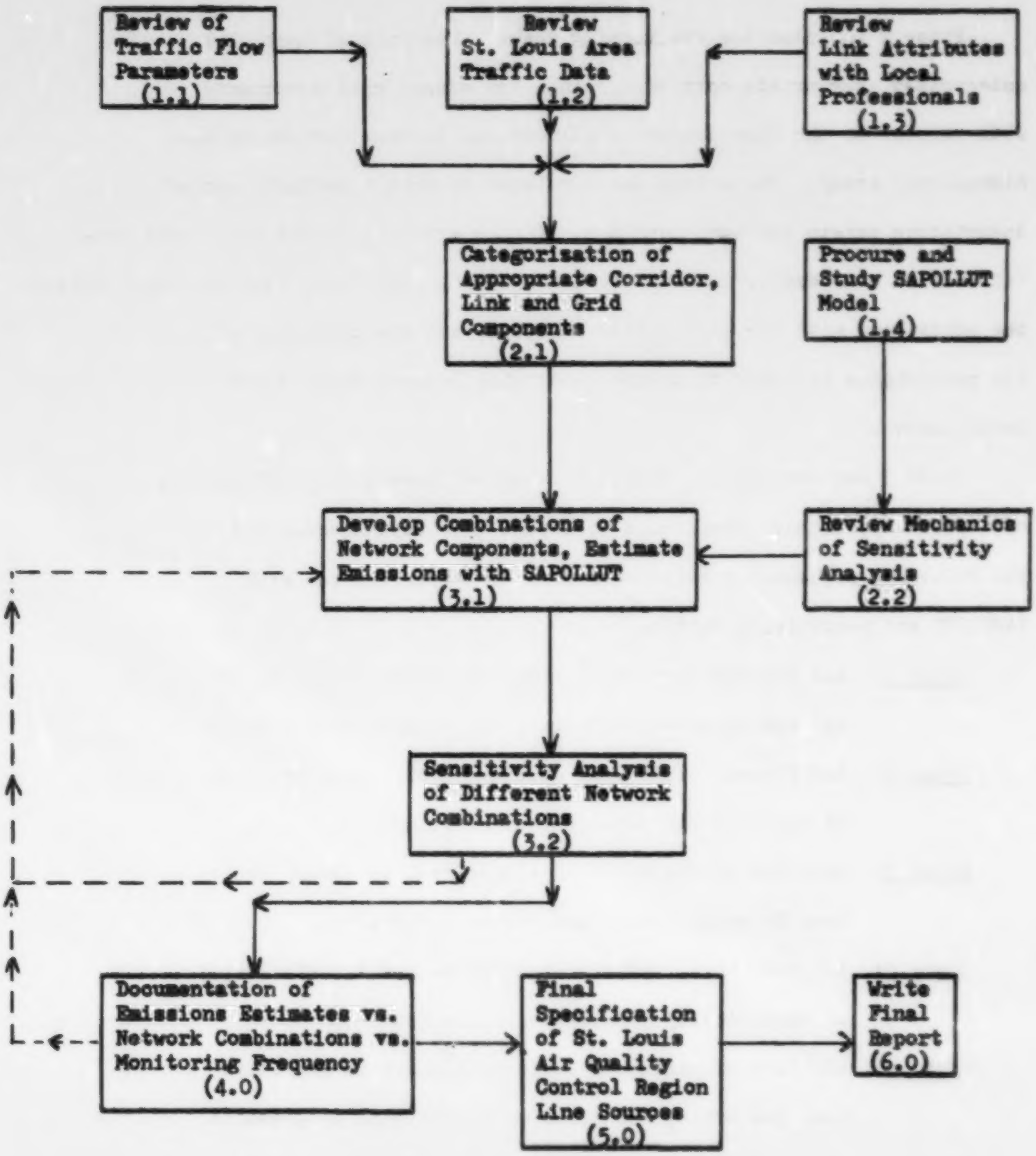

Review of Traffic Flow Parameters (1.1)
Review St. Louis Area Traffic Data (1.2)
Review Link Attributes with Local Professionals (1.3)
Categorization of Appropriate Corridor, Link and Grid Components (2.1)
Procure and Study SAPOLLUT Model (1.4)
Develop Combinations of Network Components, Estimate Emissions with SAPOLLUT (3.1)
Review Mechanics of Sensitivity Analysis (2.2)
Sensitivity Analysis of Different Network Combinations (3.2)
Documentation of Emissions Estimates vs. Network Combinations vs. Monitoring Frequency (4.0)
Final Specification of St. Louis Air Quality Control Region Line Sources (5.0)
Write Final Report (6.0)

FIGURE 9. Research Work Plan

Phase 2 included two overlapping tasks. The initial task, 2.1 categorized appropriate corridors, links and street grid components with respect to the flow phenomena illustrated in the previous three-dimensional array. The coding was developed so that a complete set of descriptors exists for each corridor, link or arterial street grid level conceptualized and developed as input. Overlapping with this, task 2.2 familiarized the study team with the sensitivity analysis, and the mechanics of its performance in order to assure continuity between Phase 3 and later phases.

Phase 3 had two tasks. Task 3.1 developed levels and combinations of network hierarchial components as inputs to studying emissions. The following sequence of components were developed for use with SAPOLLUT and sensitivity testing:

Round 1: All freeway corridors, link components broken up by average speed differentials and volume differentials.

Round 2: All freeway corridors, additional breakdown by sites of specifically complex configuration.

Round 3: Addition of the arterial street grid to above, broken down by speed, delay and volume differentials.

Round 4: All the above, additional breakdown by arterial sites of specifically complex configuration.

Round 5: Addition of refined locations adjacent to sensitive land use areas, and areas of exceptional progression.

Round 6: All of the above, cross classified by vehicle mix.

Thus, the approach is to ultimately yield a descriptive network of line sources N, which is composed of

$$N = \sum_{i,j,k,m,n,o,p,q,\ldots\ldots t} \ell_{ijkmnopq\ \ldots\ldots t}$$

where ℓ is a specific link or network component and i, j, k, m, n, o, p, q ..... are its flow parameters shown in the three-dimensional array, and t is the monitoring frequency. At each of the above rounds, the network could be input to SAPOLLUT, and emissions information estimated. The network is synthesized in a sequential manner through the several rounds, to develop clarity about its composition and emissions output, allowing for a more orderly sensitivity analysis.

Task 3.2 articulated changes in the above synthesized network and site monitoring frequency. From knowledge of the local area, specific link and network components developed through all of the above rounds were removed or added, noting through the use of SAPOLLUT in a sensitivity analysis, the change in resulting emissions information. The sensitivity analysis of the coded link and network components was developed in a batch software format, to allow a certain programmed sequence of network alterations to occur. This process was hooked with SAPOLLUT, to allow network input operations and emissions estimation to occur in one continuous software run.

Phase 4 documented the results of the use of SAPOLLUT and the sensitivity analysis carried on in 3.2. Reference to Figure 9 shows feedback and interaction across 3.1, 3.2 and 4 to adequately formulate test, converge and document the above processes.

Phase 5 utilizes the above array of sensitivity and convergence information and specifically states network component locations, their frequency of emissions monitoring, and the required traffic flow-related data. This specification defines the emission line sources for the St. Louis Air Quality Control Region.

Phase 6 combines previous conceptual analysis, the computer software, associated network synthesis, use of SAPOLLUT and the sensitivity analysis and its results, with specifications for refinement and further research into a final written report contained herein. The following text will elaborate on data collection, software development, use of SAPOLLUT, sensitivity analysis and definition line sources, and provide appropriate appendices on software documentation and data formats.

Footnotes Chapter I

[1] Federal Register, Volume 36, No. 84, Friday, April 30, 1971.

[2] Scott Research Laboratories, Inc., Development of Representative Driving Patterns at Various Average Route Speeds, EPA No. 68-02-1301 (6-73). February 11, 1974, San Bernadino, California.

[3] Ibid., pp. 3-1 through 4-18.

[4] Sturman, G. M., The Effect of Highways on the Environment, May, 1970.

[5] Steering Group and Working Group Appointed by the Minister of Transport, Great Britain, Cars for Cities, 1967.

CHAPTER II

DATA DEVELOPMENT

An assessment of highway line sources with respect to emissions requires that the road network under study be classified according to a set of parameters that allows appropriate hierarchial analysis, since some links will be much more critical from an emissions standpoint than others.

The data collection effort focused on those areas designated as urban and urbanizing. The East-West Gateway Coordinating Council defines these areas to include the City of St. Louis, St. Louis County, and parts of St. Charles and Jefferson Counties in Missouri. In Illinois part of Monroe, and Madison and St. Clair Counties are included.

Roadway data was collected within this area in light of emissions and their sensitivity to highway functional class, volume and composition of vehicles present, and the operational characteristics of vehicles related to both traffic volume and average speed alterations due to roadway alignment and profile. Other data collected, such as the intensity and type of the adjacent land use is relevant, along with certain highway design characteristics, to the localized air quality.

A number of agencies were contacted to compile the inventory. They included the East-West Gateway Coordinating Council, Missouri State Highway Department Jefferson City Office and St. Louis Office, the Region VII Office of the Illinois Department of Transportation, the Office of the Deputy Commissioner of the City of St. Louis Street Department, St. Louis County Division of Highways and Traffic, and the City of St. Charles.

A working set of highway links was established through the use of East-West Gateway's 7001 link-node map for the entire region under study. Actual street names for all links were recorded from maps provided by the Auto Club of Missouri.

The initial major data collection effort was for the freeway functional class. Volume and vehicle attributes sought for each link were average daily traffic, peak hour traffic, hourly distribution of traffic, percent of heavy duty vehicles, and the directional distribution of traffic. All the above were obtained for the Missouri counties except percent heavy duty vehicles. However, in Illinois, only average daily traffic and percent heavy duty vehicle data was available.

Link attributes sought to describe vehicle operating characteristics were the volume to capacity ratio (V/C), peak hour speed by direction, off peak speed by direction, frequency of complex interchanges, lane drops and existing freeway bottleneck sections. The capacity information obtained from East-West Gateway was a representative daily capacity factored down to obtain a peak hour V/C ratio at level of service E.[1] An hourly V/C ratio table was given in the SAPOLLUT users manual based on an hourly speed distribution. Current peak hour speed data by direction was available for 75% of the area freeway links from East-West Gateway. Through the cooperation of the Illinois Department of Transportation and local agencies in St. Louis and St. Louis County, a complete set of links with complex interchanges, lane drops, and major freeway bottlenecks was compiled. The study team drove the network to collect information on roadway topography as a freeway link descriptor. Four terrain types were categorized: high fill, deep cut, rolling terrain, and level terrain.

As a final set of link descriptors for the freeway functional class, land use by type and intensity was sought. East-West Gateway provided an area map delineating high density regionally oriented land uses. Types included commercial, educational, medical, recreational, and airport.

The next major data collection effort was for principal arterial roadways. These roadways are characterized by a minimum number of intersections at grade. Such intersections are typically designated to provide channelization and signal synchronization to enhance the traffic movement along the arterial. The link attributes sought to describe volume and vehicle composition were as before, average daily traffic, peak hour traffic, hourly distribution of traffic, percent of heavy duty vehicles, and the directional distribution of travel. The same data gaps that existed for freeways exist for principal arterials in this attribute set. In addition to volume to capacity ratios, peak hour directional speed, off peak directional speed, lane drops, and general roadway bottlenecks were collected as link attributes for vehicle operating characteristics. Further, information concerning the degree of progressive movement was sought. Progressive movement is typified by a continuous flow of a platoon of vehicles over long stretches of highway. Such movement can be induced by the type of signal systems employed at intersections and the distribution of one-way streets. It is desirable to separate out links that have progressive movement since the degree of vehicle delay is much less than on arterials without it. Attributes for progression included links with pre-timed signal systems, physically interconnected signal systems, and one-way street flows. The City of St. Louis, St. Louis County, Missouri State Highway Department, and the Illinois Department of Transportation provided us with complete information on this attribute set.

As in the freeway case, sensitive land uses were included as link descriptors. In addition to those already listed, the central business district was included as an area type in the inventory. This was done to aid in the delineation of an additional topography attribute, the categorization of street canyons.

The final data collection report was for minor arterial roadways. Such roadways provide for both traffic movement and land access. The data sought was the same for principal arterials and had the same data gaps.

In total, 28 link descriptors across three functional classes of highway were assembled. This data was compiled on an individual link basis, coded for keypunching and readied for input into the software system to be described in Chapters III and IV. The collection and coding format is illustrated in Appendix B.

Footnotes Chapter II

[1] Level of Service E represents operation of the system with volume at or near capacity. Operating speed is relatively low, flow is unstable and momentary stoppage occurs; the system is on the verge of complete jam and saturation with attendant congestion effects.

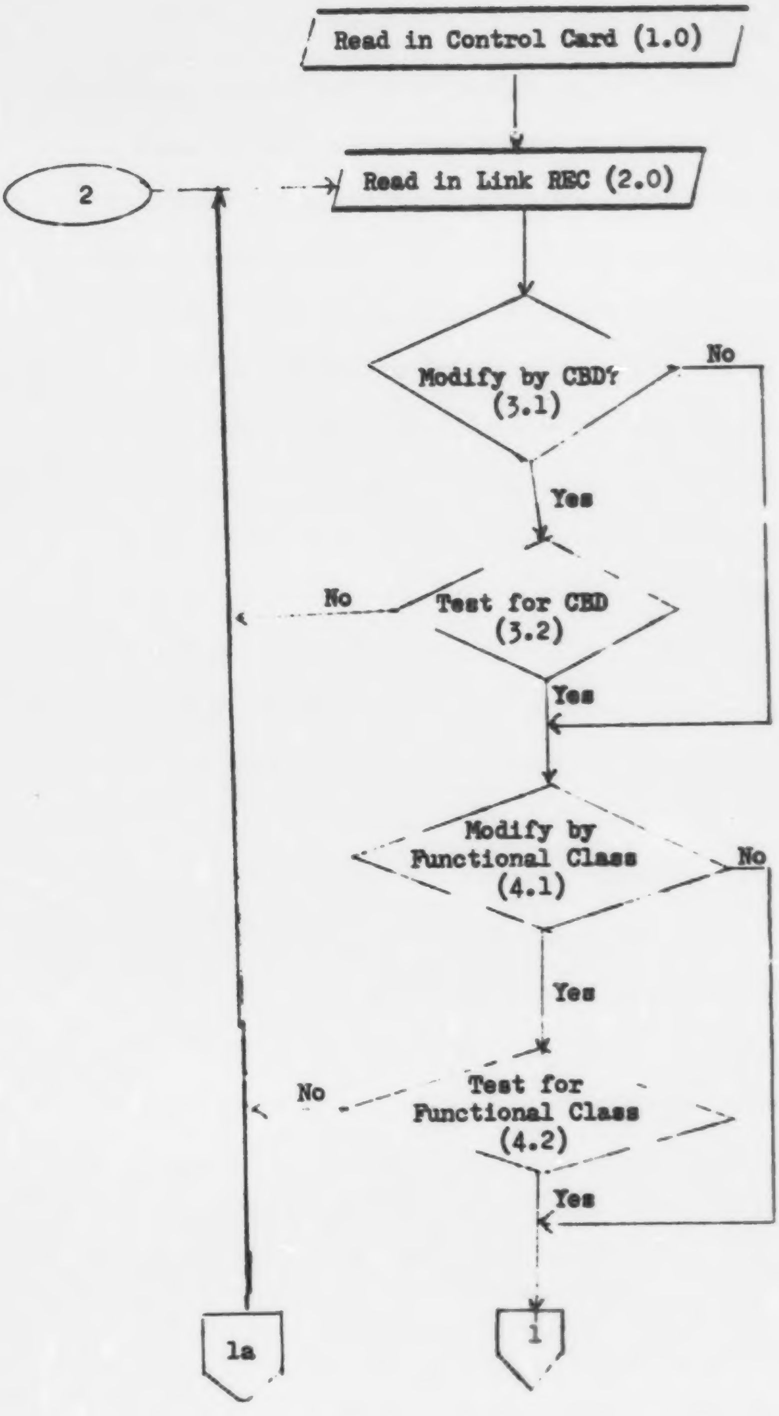
CHAPTER III

MODEL DEVELOPMENT

A. OVERVIEW OF MODEL LOGIC

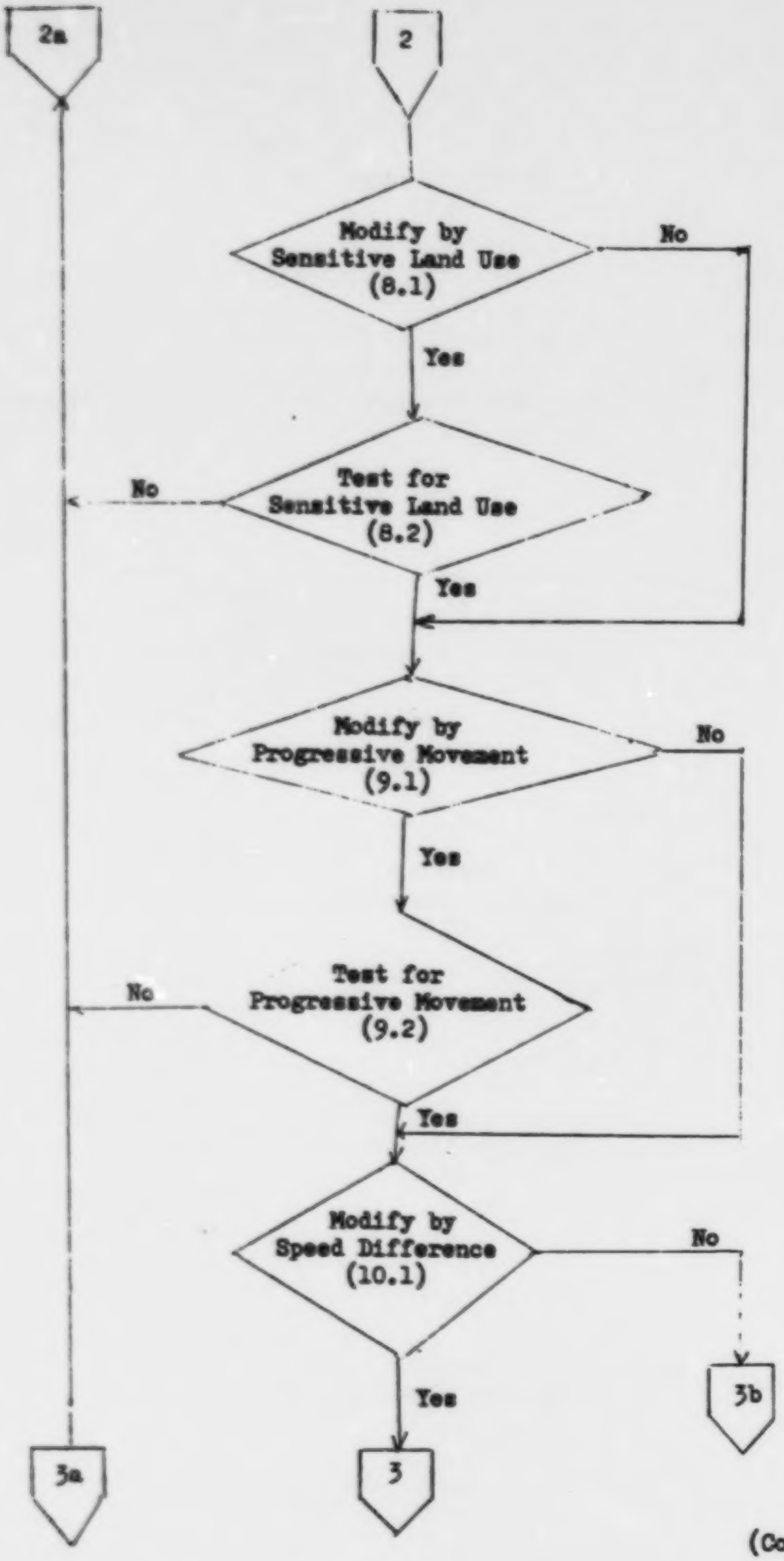
This chapter describes the logic construct of the network sensitivity model NETSEN, and its interface with the emissions estimation model SAPOLLUT. The flow chart of the master logic for the model NETSEN is shown in Figure 10. In general, the model works by defining a series of sequential tests of presence of network related attributes shown in steps 2.0-13.0. These are presence of the link within the Central Business District (i.e., the Downtown Core Commercial Area), functional class of the link, its ADT, presence of special topography, capacity alterations, presence of sensitive land uses, presence of progressive movement, speed difference, truck volumes, and V/C ratio. After reading the coded link data records in, with step 2.0, each link is tested to sort and classify it according to combinations of attributes present in it. Those groups of links thus containing certain combinations specified in the control card in step 1.0 are then output to SAPOLLUT for use in estimating emissions. A complete description of the software documentation is given in Appendix A. Two specific points are important in overviewing the logic at this point:

1.) The network and any link subset component of it can be tested at any level of data attributes relevant, from very gross descriptions containing only ADT information, to very refined descriptions of the network, classifying and locating all of the attributes shown in steps 2.0-13.0 on the network.

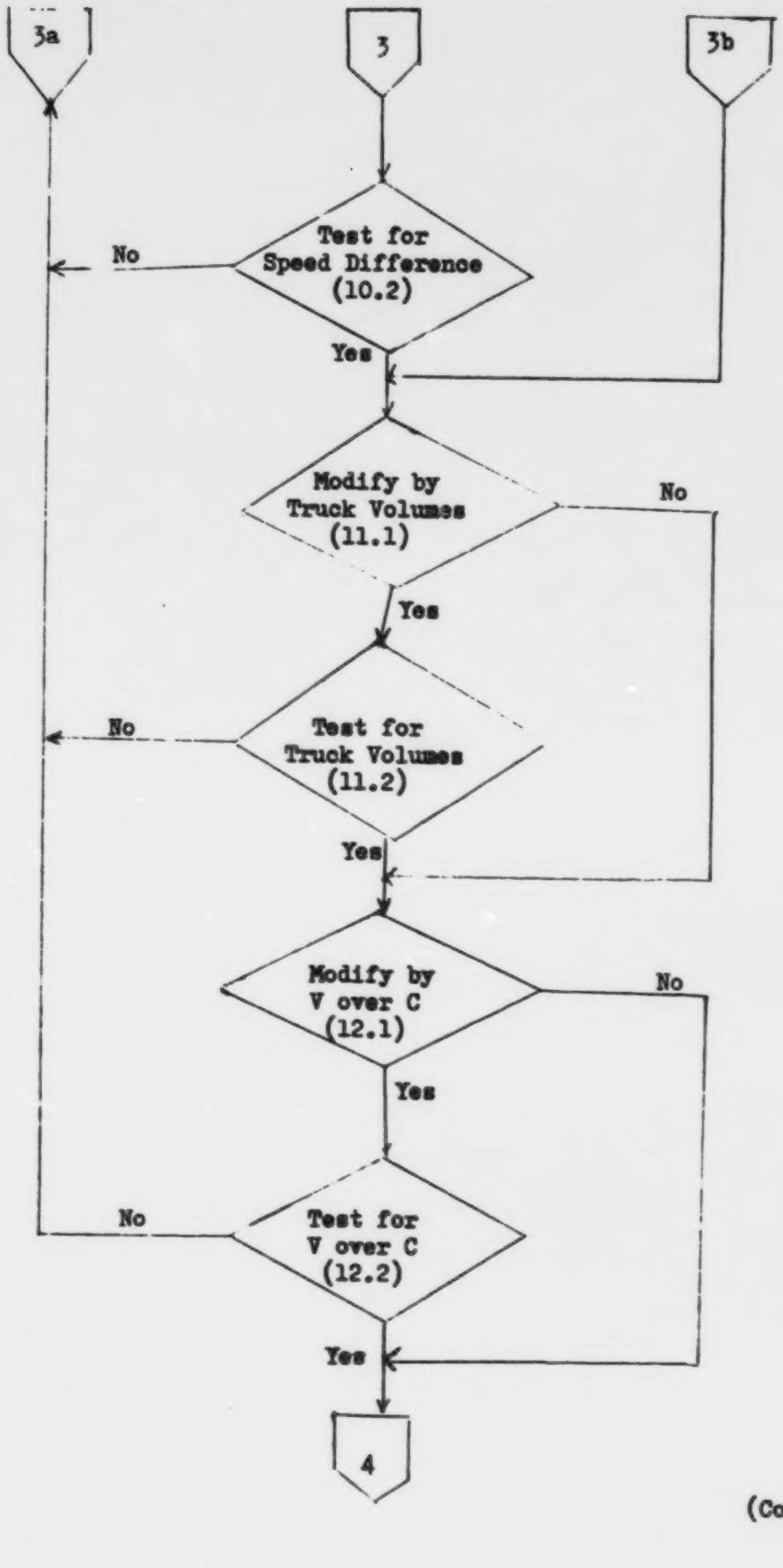

Read in Control Card (1.0)
2
Read in Link REC (2.0)
Modify by CBD?
(3.1)
No
Yes
No
Test for CBD
(3.2)
Yes
Modify by
Functional Class
(4.1)
No
Yes
No
Test for
Functional Class
(4.2)
Yes
1a
1

(Continued)

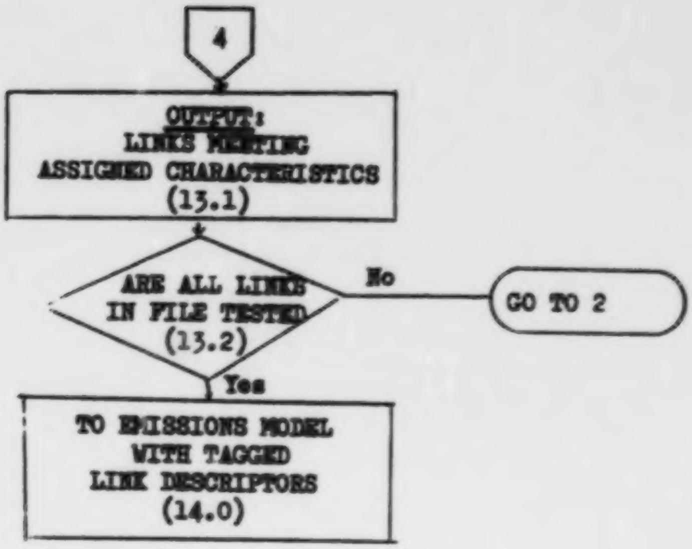
FIGURE 10. Master Logic of NETSEN Model


2a
2
Modify by
Sensitive Land Use
(8.1)
No
Yes
No
Test for
Sensitive Land Use
(8.2)
Yes
Modify by
Progressive Movement
(9.1)
No
Yes
No
Test for
Progressive Movement
(9.2)
Yes
Modify by
Speed Difference
(10.1)
No
Yes
3b
3a
3

(Continued)


3a
3
3b
Test for Speed Difference (10.2)
No
Yes
Modify by Truck Volumes (11.1)
No
Yes
Test for Truck Volumes (11.2)
No
Yes
Modify by V over C (12.1)
No
Yes
Test for V over C (12.2)
No
Yes
4

(Continued)


4
OUTPUT:
LINKS MEETING
ASSIGNED CHARACTERISTICS
(13.1)
ARE ALL LINKS
IN FILE TESTED
(13.2)
No
GO TO 2
Yes
TO EMISSIONS MODEL
WITH TAGGED
LINK DESCRIPTORS
(14.0)

2. The level of attribute refinement chosen to be tested for may be varied with the refinement of detail of data present on the network the user has access to, or the level of refinement deemed necessary for the user to study emissions. Thus, complete flexibility exists in describing the traffic related behavioral aspects of the network as related to emissions estimation.

B. SOFTWARE SYSTEM DEVELOPMENT

A discussion of the formal software system and interface with SAPOLLUT should be prefaced with brief mention of the traditional Urban Transportation Planning (UTP) background of SAPOLLUT. The implication is that the model was designed to link to the FHWA programming battery which performs the UTP process of trip generation, trip distribution and traffic assignment, with the attendant problem of using a loaded traffic assignment network versus actual ground counts.[1] The design of the UTP process makes it necessary to modify some software usage in order to use realistic ground counts in SAPOLLUT.

The completed software system correctly employing these modifications is shown in Figure 11. The system begins with the sequential file of the network link records of data attributes (1.1). The complete documentation of the format of this file is in Appendix A. The system branch containing program modules 1.2, 1.3 and 1.4 is an initialization routine executed only one time to set up the system's

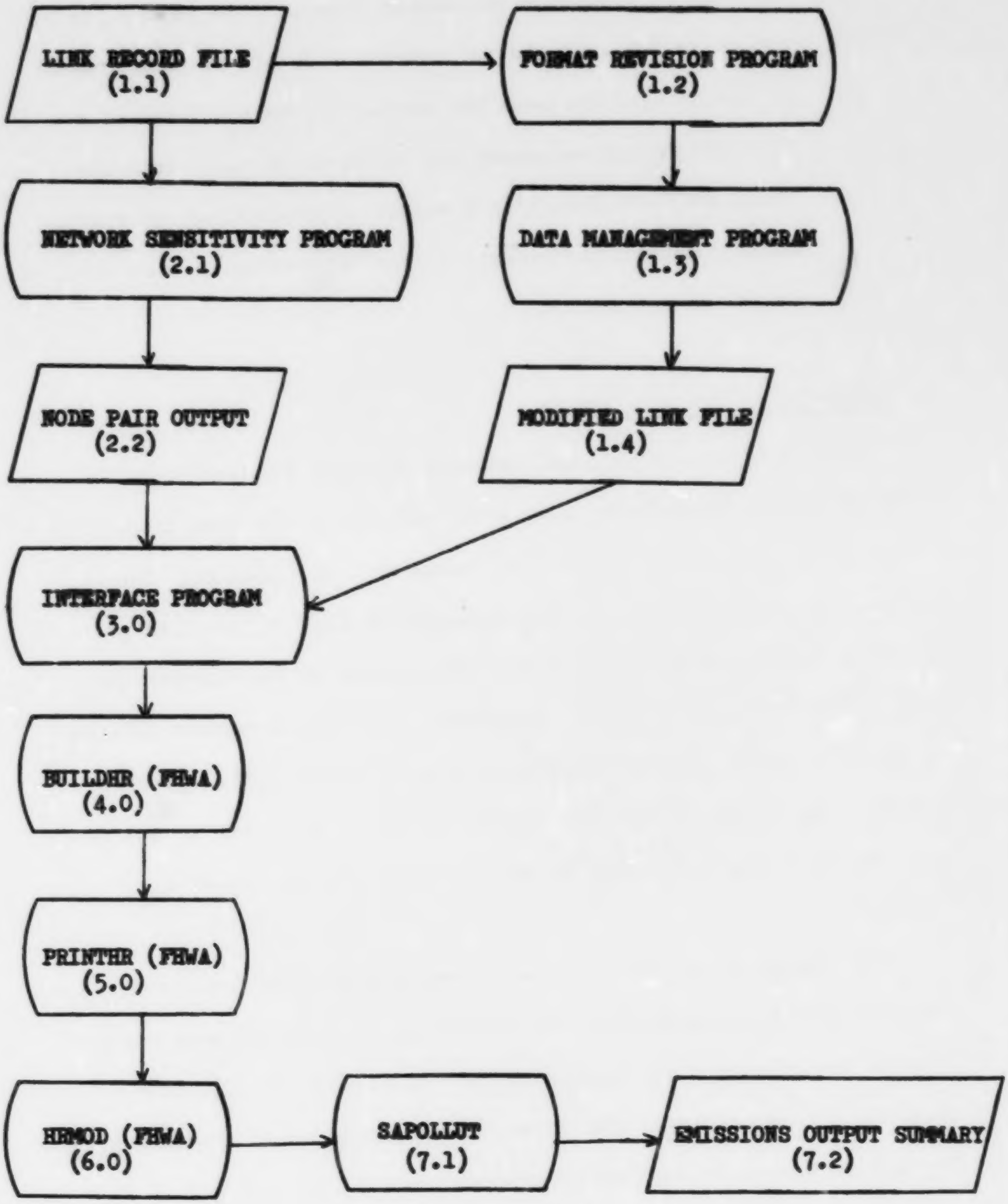

LINK RECORD FILE
(1.1)
FORMAT REVISION PROGRAM
(1.2)
NETWORK SENSITIVITY PROGRAM
(2.1)
DATA MANAGEMENT PROGRAM
(1.3)
NODE PAIR OUTPUT
(2.2)
MODIFIED LINK FILE
(1.4)
INTERFACE PROGRAM
(3.0)
BUILDHR (FHWA)
(4.0)
PRINTHR (FHWA)
(5.0)
HRMOD (FHWA)
(6.0)
SAPOLLUT
(7.1)
EMISSIONS OUTPUT SUMMARY
(7.2)

FIGURE 11. Traffic Emissions Software System

operation. The format revision program HRCVRT (1.2), takes the link record file as input and transforms it into output which will eventually be in a usable format for input into the FHWA program BUILDHR in step 4.0.

As such, module 1.3, referred to as the Data Management Program, accepts as input the link records from the Format Revision Program. The program creates what is called an indexed sequential data set. Essentially, this implies attaching a key to each link record so that it may later be retrieved with a single command, obviating a search procedure. The output of the program, termed a modified link (1.4) file, is essentially the same as its input except for the above keyed reorganization to speed access. It is important to emphasize that this program does not make any functional changes in the link records and its function could be performed elsewhere in the system. As noted earlier, this program is only executed once for all runs of NETSEN.

The next program in the software is the Interface Program (3.0), and as its name implies, it is the heart of the interfacing procedure. It accepts input from two places. First, it accepts a node pair output (2.2) from the NETSEN Program (2.1) which has passed all logic tests in that program. It then uses this node pair as a key to retrieve with a single statement the link record from 1.4 which is identified by the node pair. The program then processes the link by producing a dummy link to connect to its A-node if the previous link already processed does not have a B-node which is the same as the current A-node. The program then checks to see if the A-node is numerically less than the B-node, and if so the two are reversed. Further action takes the sum of the A-B volume count and the B-A volume count and places this sum minus 1000 in an A-B count location. The program then makes a series of edit checks to assure that valid links or dummy links do not violate any of the traffic assignment coding conventions for leg numbers and to assure that the proper count volumes are passed to SAPOLLUT. The output is a network compatible to the historical record building program, BUILDER, in 4.0.

The next program in the software system is the FHWA BUILDER program. The program accepts link records as input, and functionally, the program performs edit checking on them for consistency in coding, ultimately outputting a binary historical record for each link and also one for each node. The types of edit checking done by BUILDER include checking for unusually long links, excessively large volume-to-capacity ratios as well as duplicate node and leg numbers.

Another FHWA program, PRINTER (5.0), follows in the software system. The program accepts the binary historical records as input from BUILDER and prepares a printed summary of information in the records which is useful in checking for proper operation of preceding programs as well as for interpreting the output of SAPOLLUT on the basis of a specific set of links. Although this program is not functionally necessary for operation of the system, it provides useful information at a small cost.

The final interface program preceding SAPOLLUT is the FHWA program, HRMOD (6.0). This program is necessary because of SAPOLLUT's orientation toward traffic assignment loaded networks. Although the basic historical record has ground count information included in it, SAPOLLUT can not use it in its storage location. It is necessary to relocate actual ground count data from their storage locations in the historical record to those storage locations where traffic assignment loads would normally be. The program HRMOD is used to shift the ground counts to the locations where the loads are normally situated. It then outputs this modified historical record to SAPOLLUT.

The last program in the software system is the emissions model SAPOLLUT (7.1). It receives the modified historical record from HRMOD and several control cards as input. It then proceeds to compute three types of emissions (HC, CO, NO_x) for three different area types (CBD, Central City, Suburb)^2 and two different functional classes, freeways and arterials, using vehicle miles of travel and average speed input, the latter developed by one of three alternative methods available to the program. The emissions output is currently available only in the aggregate, broken down by area type, hour of the day, and functional class across each emission type. By further dividing gross kilograms of emissions by vehicle-miles traveled it provides emissions in grams per vehicle-mile and grams per passenger-mile, given an average auto occupancy level.

In its current state the software system is fully automated in batch mode. Thus, when the network inventory is loaded onto a tape or disk data set and the initialization programs (Format Revision Program (1.2) and Data Management Program (1.3)) are run once, the system can execute several runs of NETSEN, examining the network at several levels of refinement, with one submittal to the computer. By providing a series of control cards to NETSEN, separate member data sets for each run are created, saving the individual sets of node pairs to be processed all the way through SAPOLLUT on successive runs through the system. This enables the user to rapidly analyze the network with a set of pre-determined runs. It should be emphasized that no manual interface is necessary during this process. The following chapter will demonstrate the flexibility and solution properties of the system operation in documenting line sources for the St. Louis Air Quality Control Region.

Footnotes Chapter III

[1] Program Documentation, Urban Transportation Planning, March 1972, Federal Highway Administration. A loaded network is defined as a transportation planning network in which the traffic volumes on various links are the result of theoretical computation. A ground count is defined as the actual recorded count of vehicles on a roadway link, generally made by mechanical counting devices.

[2] Central Business District is the downtown commercial core; the Central City is the non-commercial downtown core area, and the suburban area is the outlying area of lesser density.

CHAPTER IV

DOCUMENTATION OF EMISSION LINE SOURCES

A. Introduction-Issues in Defining Line Sources

As previously discussed, useful definition of line sources hinges on the capability to analyze the highway network and its traffic and design attributes at varying levels of detail, depending on the data availability and the level of spatial refinement sought in emissions information from SAPOLLUT. As such, this chapter demonstrates the development of a very unrefined definition of line sources, termed gross line sources, and the sequential refinement of such to a set of descriptors termed ultimate line sources. Each of these extremes of definition are consistent with the basic definition of a line source, given immediately below in Section B.

B. Basic Definitions-Delineation of Gross Line Sources

The following basic definition of a line source was employed in documenting emissions for the St. Louis Regional network:

> "the smallest segment of inventoried roadway depictable with a given specific set of attributes for the roadway."

At the grossest level, the line sources were broken down in the categories depicted by Table 1. The X's indicate which ADT ranges were used for functional classes of roadway. In addition, separate baseline runs were made to select all freeways, all principal arterials, and all minor arterials within these ADT classes. The emissions produced by this gross ADT breakdown of line sources are summarized in the following set of figures and tables for 24-hour periods:

1. Figure 12 represents those freeway links in each of the ADT ranges from Table 1. Table 2 presents vehicle-miles travelled (VMT), total emissions, and emission rates for freeways in each of these ADT ranges.

2. Figure 13 represents those principal arterial links in each of the ADT ranges from Table 1. Table 3 presents VMT, total emissions, and rates for principal arterials in each of these ADT ranges.

3. Figure 14 represents those minor arterial links in each of the ADT ranges from Table 1. Table 4 presents VMT, total emissions and rates for minor arterials in each of these ADT ranges.

A composite analysis of these tables leads to conclusions generally consistent with the literature, subject to subtle interpretation which must be employed when aggregating emissions information over all links under study in a particular functional class. Total kg of emissions over all categories (CO, NO_x, and HC) rank lowest for minor arterials, reflecting lowest VMT exposure. Both the freeways and principal arterials have very similar VMT totals. However, the freeways exhibit lower totals for CO and HC, and higher NO_x totals than the principal arterials, reflecting consistently lower average speeds on the arterials. The CO rates (grams/vehicle mile) show the most noticeable change across ADT ranges for all functional classes, with the most sharp changes associated with the last three ADT ranges in each class. This is apparently due to the distinct reduction in average speed associated with links at these particular ADT ranges nearing or exceeding saturation for their functional class. HC and NO_x, however, show generally stable emissions totals across all functional classes. The HC rate rises slightly, reflecting the aggregate impact across all links in the network of reduced average speed

ADT Ranges (Thousands)	Freeways	Principal Arterials	Minor Arterials
1-30	X		
30-40	X		
40-50	X		
50-60	X		
60-70	X		
70-200	X		
5-10		X	X
10-15		X	X
15-20		X	X
20-25		X	
25-30		X	
30-35		X	
35-40		X	
40-100		X	
20-40			X

TABLE 1

ADT RANGES USED FOR GROSS
LEVEL LINE SOURCE DEFINITION

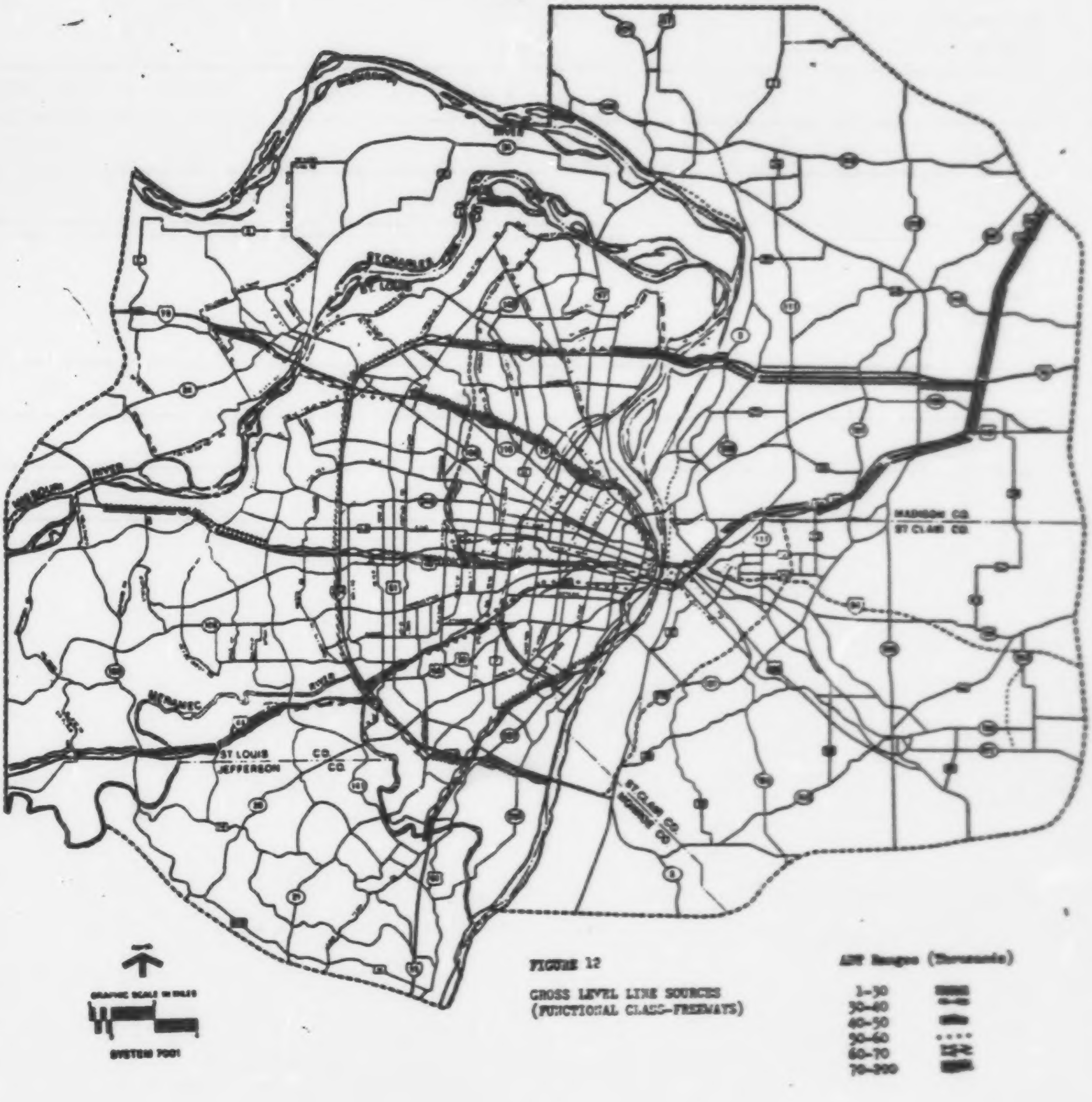

MISSISSIPPI
ST CHARLES CO.
ST LOUIS
MISSOURI RIVER
MERAMEC RIVER
ST LOUIS CO.
JEFFERSON CO.
MADISON CO.
ST CLAIR CO.
ST CLAIR CO.
MONROE CO.
GRAPHIC SCALE IN MILES
SYSTEM 7001

FIGURE 12

GROSS LEVEL LINE SOURCES
(FUNCTIONAL CLASS-FREEWAYS)

ADT Ranges (Thousands)

1-30
30-40
40-50
50-60
60-70
70-200

	ADT Ranges (Thousands)						
	1-30	30-40	40-50	50-60	60-70	70-200	Total
VMT (24 hours)	624,407	563,007	889,163	1,015,384	1,728,011	2,774,162	7,594,134
Emissions (kilograms/24-hr. period)							
CO	10,906	10,221	16,876	20,849	35,901	60,375	155,128
NO_x	5,809	5,133	7,929	8,701	14,747	23,163	65,482
HC	2,257	2,073	3,340	3,956	6,773	11,126	29,525
Emissions Rates (grams per vehicle-mile)							
CO	17	18	19	21	21	22	
NO_x	9	9	9	9	9	8	
HC	4	4	4	4	4	4	

TABLE 2

GROSS LEVEL LINE SOURCE EMISSIONS
(FUNCTIONAL CLASS-FREEWAYS)

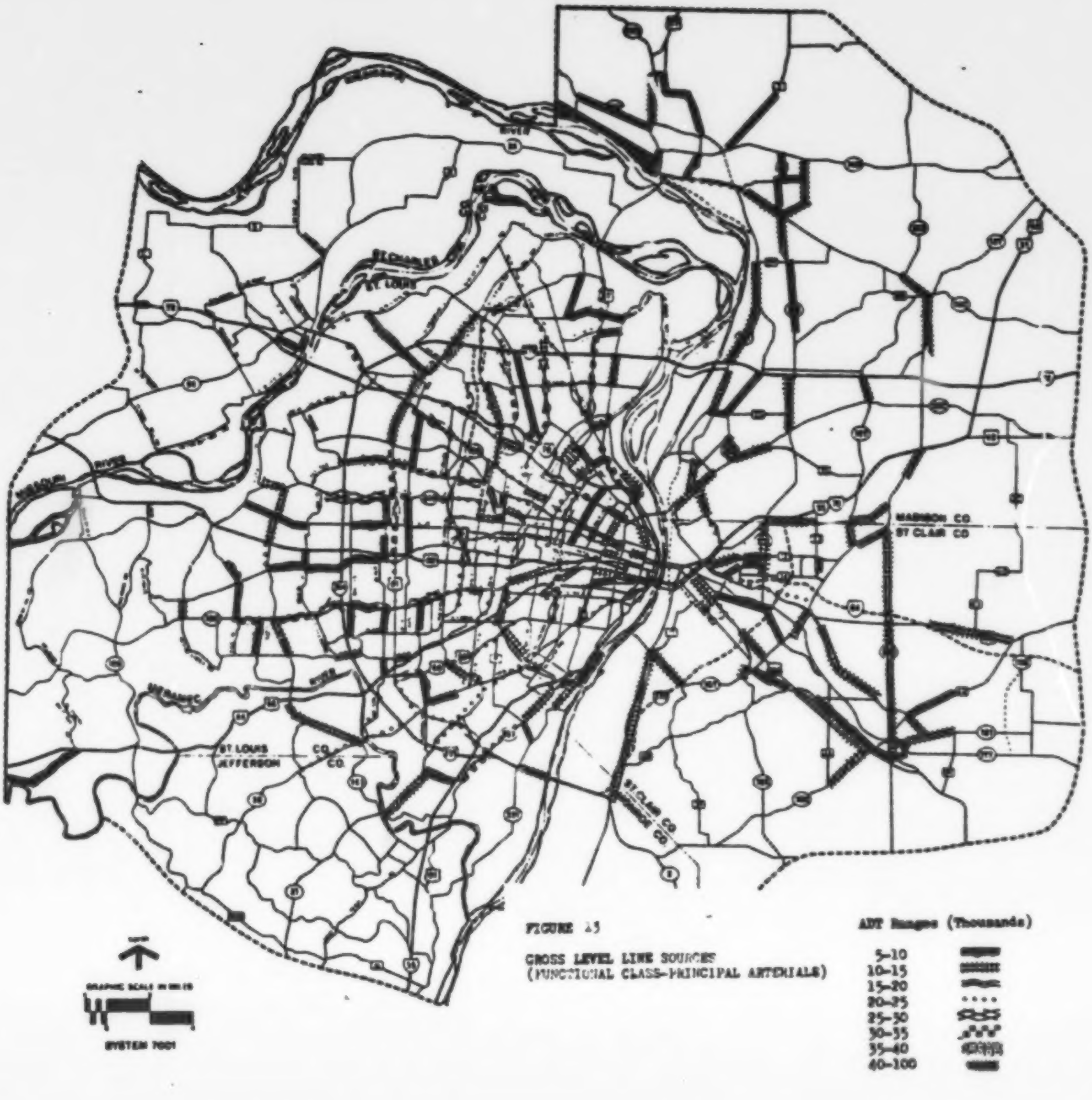

MISSOURI RIVER
ST CHARLES
ST LOUIS
RIVER
MERAMEC RIVER
ST LOUIS CO
JEFFERSON CO
MADISON CO
ST CLAIR CO
ST CLAIR CO
MONROE CO
NORTH
GRAPHIC SCALE IN MILES
SYSTEM 7001
ADT Ranges (Thousands)
5-10
10-15
15-20
20-25
25-30
30-35
35-40
40-100

FIGURE 45

CROSS LEVEL LINE SOURCES
(FUNCTIONAL CLASS-PRINCIPAL ARTERIALS)

ADT Ranges (thousands)

	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-100	Total
VMT (24 hours)	672,528	1,576,094	1,482,781	1,564,475	1,190,306	622,281	134,964	205,360	7,448,789
Emissions (kilograms/24-hour period)									
CO	21,545	52,802	51,358	53,330	45,273	26,201	5,723	8,613	264,845
NO_x	3,848	8,913	8,380	8,856	6,644	3,450	748	1,132	41,971
HC	3,325	7,982	7,610	7,973	6,384	3,498	760	1,155	38,245
Emissions Rate (grams per veh.-mile)									
CO	32	34	35	34	38	42	42	46	
NO_x	6	6	6	6	6	6	6	6	
HC	5	5	5	5	5	6	6	6	

TABLE 3

GROSS LEVEL LINE SOURCE EMISSIONS
(FUNCTIONAL CLASS-PRINCIPAL ARTERIALS)

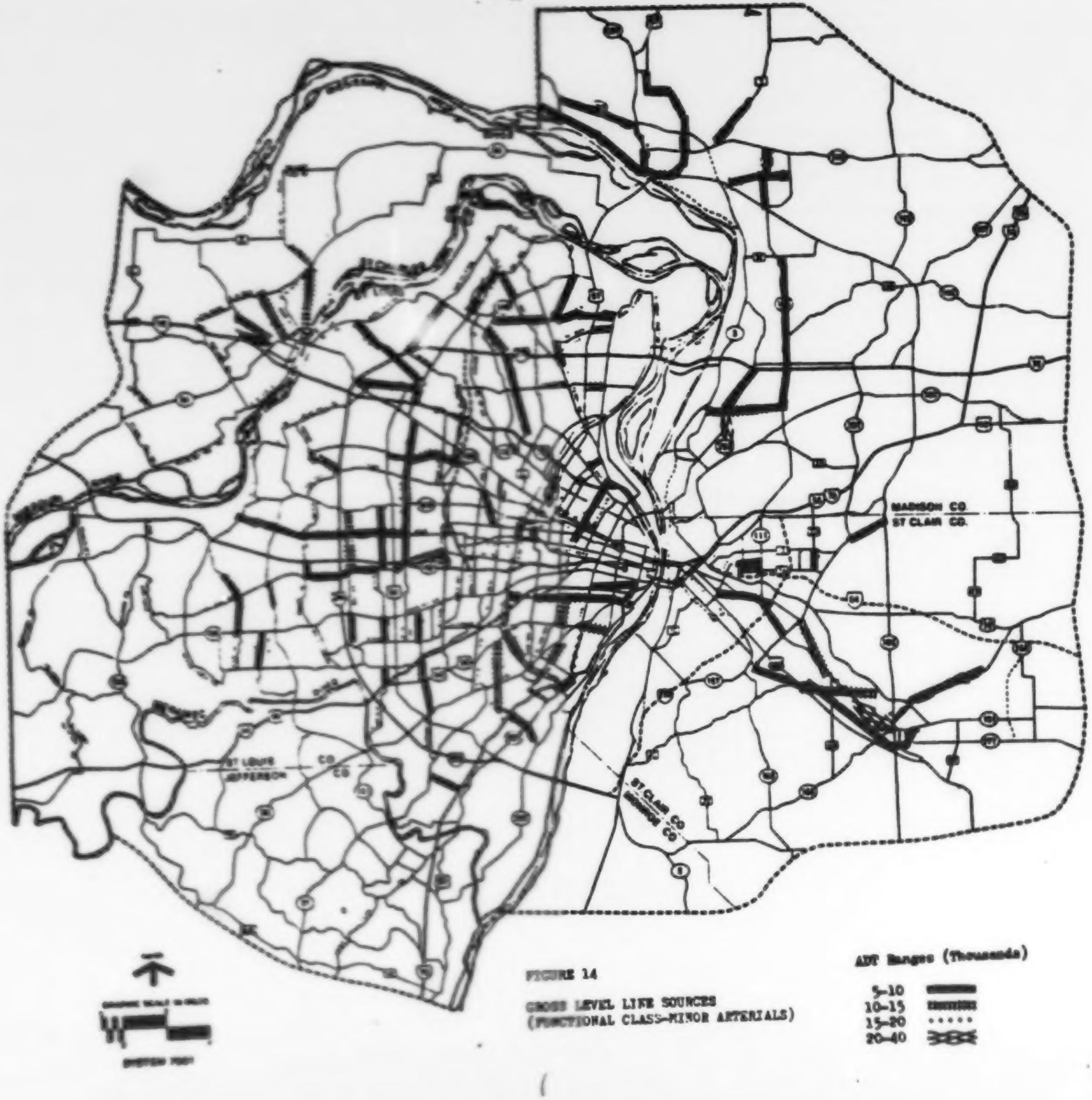

MADISON CO.
ST CLAIR CO.
ST LOUIS CO.
JEFFERSON CO.
ST CLAIR CO
MONROE CO
ADT Ranges (Thousands)
5-10
10-15
15-20
20-40

FIGURE 14

GROSS LEVEL LINE SOURCES
(FUNCTIONAL CLASS-MINOR ARTERIALS)

	ADT Ranges (Thousands)				
	5-10	10-15	15-20	20-40	Total
VMT (24 hours)	612,870	594,058	319,406	191,680	1,718,014
Emissions (kilograms/24-hour period)					
CO	20,330	19,713	12,611	9,695	62,349
NO_x	3,496	3,369	1,779	1,012	9,656
HC	3,076	2,994	1,744	1,193	9,007
Emissions Rates (g/veh.-mile)					
CO	33	33	39	51	
NO_x	6	6	6	5	
HC	5	5	5	6	

TABLE 4

GROSS LEVEL LINE SOURCE EMISSIONS
(FUNCTIONAL CLASS-MINOR ARTERIALS)

due to increased flow. The NO_x rate shows some reductions in the latter ADT ranges of each class. This is apparently due to reductions in the average speed on these higher volume sets of links which operate at or near saturated levels of congestion.

C. Refined Level - Ultimate Definition of Line Sources

The most refined level of line source definition used involved classifying the links by narrow ranges of ADT and combinations of special characteristics defining their attributes. These attributes have been noted in depth in Chapters II and III. The following paragraphs show some examples of typical 24-hour graphic and tabular information which form the ultimate definition of line sources for the St. Louis Air Quality Control Region. Detailed commentary will be reserved until synthesis of information occurs in Table 17.

The initial presentation in Table 5 exhibits the basic ADT ranges used in conjunction with the various combinations of attributes. Figure 15 represents those freeway links in the various ADT ranges for which none of the attributes of special topography, capacity alterations, or sensitive land use were present. Table 6 is an emissions summary of these links from Figure 15. Further, Figure 16 depicts those freeway links in various ADT ranges for which capacity alterations were present but not special topography or sensitive land use attributes. Their emissions are summarized in Table 7. Likewise, Figure 17 depicts those freeway links in various ADT ranges for which both special topography and capacity alterations were present, but sensitive land use attributes were not. Table 8 summarizes emissions for these particular links. Figure 18 represents those freeway links, in various ADT ranges, for which the combination of attributes of special topography, capacity alterations and sensitive land use were present. Their emissions are summarized in Table 9.

The next component series of figures and tables illustrates the most refined level of line source definition for principal arterials, using ADT ranges as noted in Table 5. Figure 19 exhibits those principal arterial links in various ADT ranges which do not have any of the attributes of capacity alteration, progressive movement, or sensitive land use present. Table 10 summarizes emissions for these links. Figure 20 depicts those principal arterial links in various ADT ranges which had attributes of capacity alteration, but no attributes of progressive movement, or sensitive land use. Their emissions are summarized in Table 11. Further, Figure 21 illustrates those principal arterial links in various ADT ranges which have attributes of capacity alteration and progressive movement, but not sensitive land use. The emissions summary for these links is shown in Table 12. Figure 22 exhibits those principal arterial links in various ADT ranges which have all the attributes of capacity alteration, progressive movement, and sensitive land use. Their emissions are summarized in Table 13.

The final example of line source definitions is composed of minor arterials in the ADT ranges previously noted in Table 5. Figure 23 illustrates those minor arterial links in various ADT ranges which did not have any attributes of capacity alterations, progressive movement, or sensitive land use. Their emissions are summarized in Table 14. Figure 24 shows those minor arterial links in various

ADT Ranges (Thousands)	Freeways	Principal Arterials	Minor Arterials
5-10		X	X
10-15		X	X
15-20		X	X
20-25		X	
20-40			X
25-30		X	
30-35	X	X	
35-40	X	X	
40-45	X		
45-50	X		
50-55	X		
55-60	X		
60-65	X		
65-70	X		
70-200	X		
40-100		X	

TABLE 5

ADT RANGES USED FOR ULTIMATE
LINE SOURCE DEFINITION

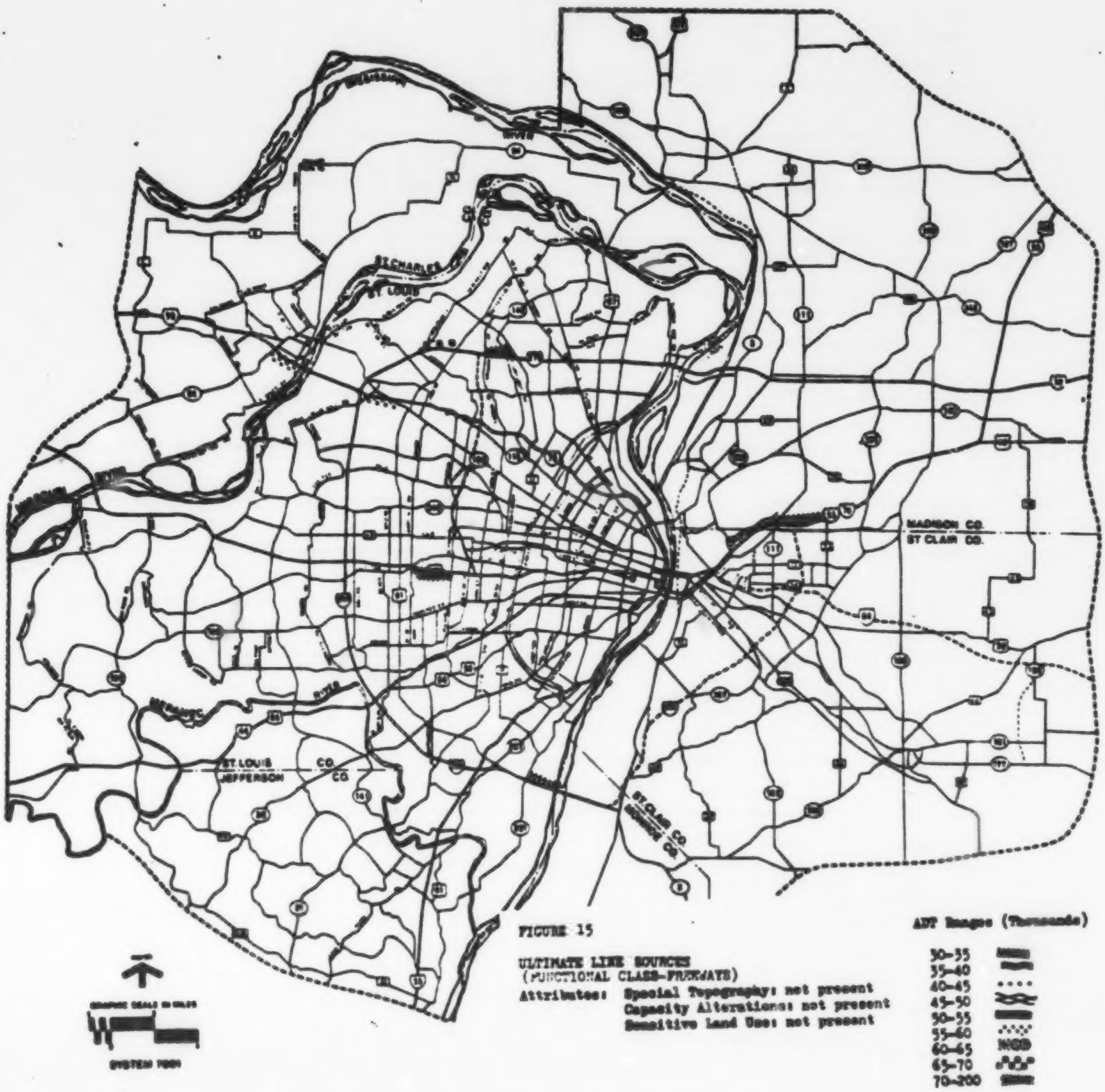

ST CHARLES
ST LOUIS
MADISON CO.
ST CLAIR CO.
ST. LOUIS CO.
JEFFERSON CO.
ST CLAIR CO.
MONROE CO.
RIVER
ADT Ranges (Thousands)
30-35
35-40
40-45 • • • •
45-50
50-55
55-60
60-65
65-70
70-200
GRAPHIC SCALE IN MILES

FIGURE 15

ULTIMATE LINE SOURCES
(FUNCTIONAL CLASS-FREEWAYS)
Attributes: Special Topography: not present
Capacity Alterations: not present
Sensitive Land Use: not present

ADT Ranges (Thousands)

	30-35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-200	Total
VMT (24 hours)	90,462	0	0	0	0	153,325	0	124,945	245,958	614,677
Emissions (kilograms/24-hour period)										
CO	2,697	0	0	0	0	2,984	0	6,598	13,242	25,521
NO_x	690	0	0	0	0	1,350	0	809	1,570	4,419
HC	424	0	0	0	0	582	0	809	1,613	3,428
Emissions Rates (g/veh.-mile)										
CO	30	0	0	0	0	19	0	53	54	
NO_x	8	0	0	0	0	9	0	6	6	
EC	5	0	0	0	0	4	0	6	7	

TABLE 6

ULTIMATE LINE SOURCE EMISSIONS
(FUNCTIONAL CLASS - FREEWAYS)
Attributes: Special Topography: not present
Capacity Alterations: not present
Sensitive Land Use: not present

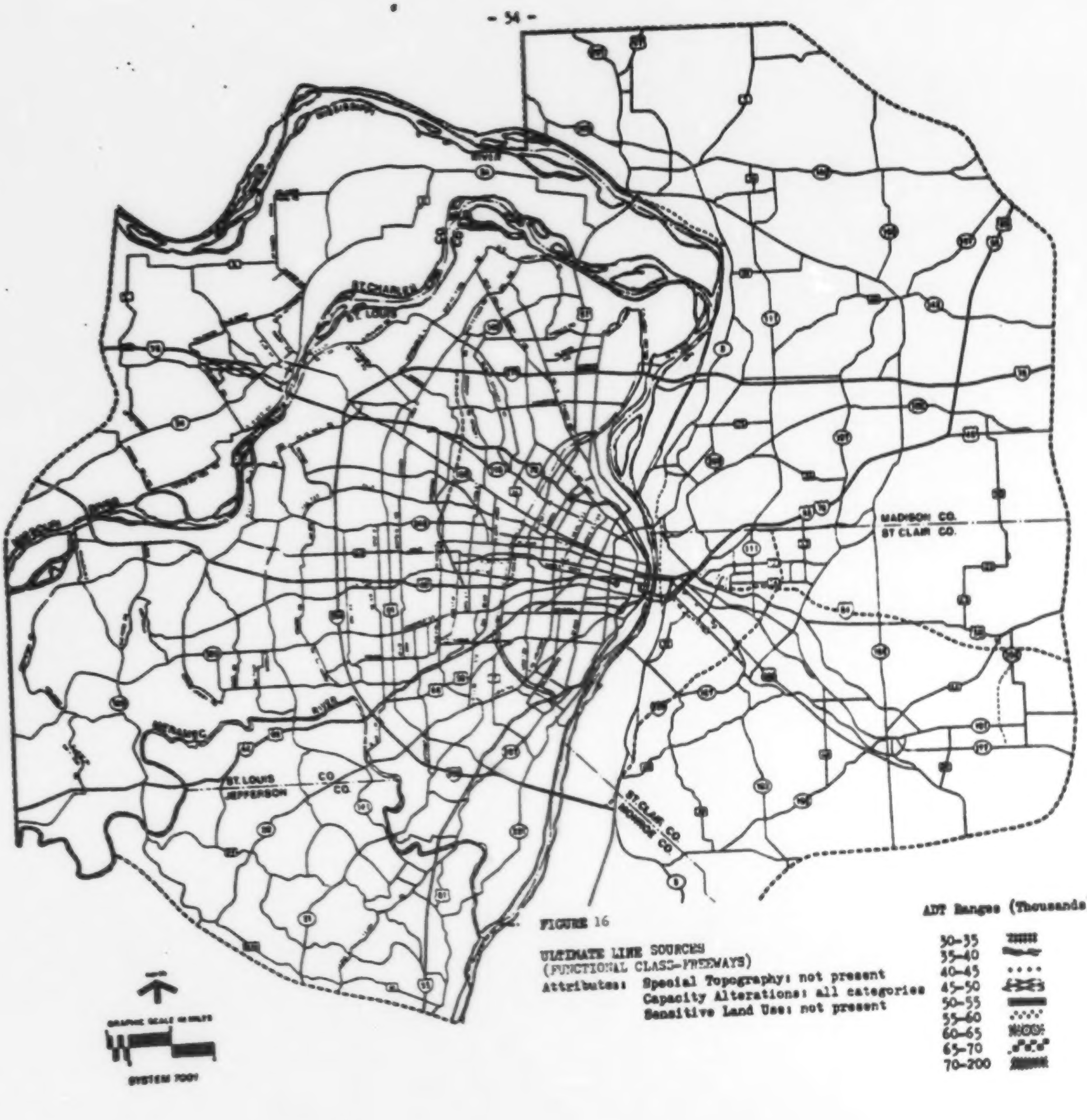

MISSISSIPPI
RIVER
ST CHARLES CO
ST LOUIS
MISSOURI
MERAMEC
RIVER
ST LOUIS CO
JEFFERSON CO
MADISON CO
ST CLAIR CO
ST CLAIR CO
MONROE CO
NORTH
GRAPHIC SCALE IN MILES
SYSTEM 7001
ADT Ranges (Thousands)
30-35
35-40
40-45
45-50
50-55
55-60
60-65
65-70
70-200

FIGURE 16

ULTIMATE LINE SOURCES
(FUNCTIONAL CLASS-FREEWAYS)
Attributes: Special Topography: not present
Capacity Alterations: all categories
Sensitive Land Use: not present

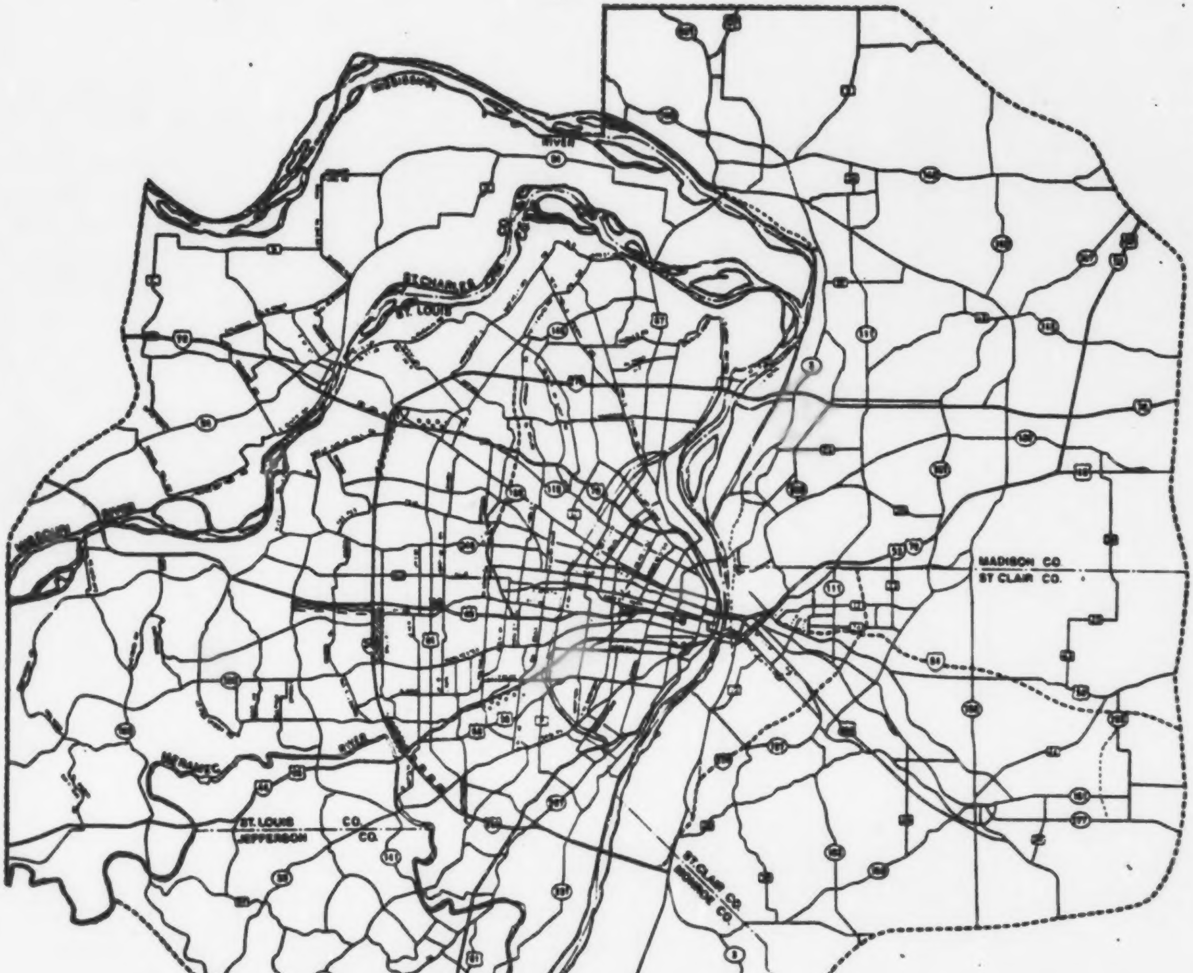
ADT Ranges (Thousands)

	30-35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-200	Total
VMT (24 hours)	0	0	0	133,200	53,388	0	0	0	0	186,588
Emissions (kilograms/24-hour period)										
CO	0	0	0	2,520	355	0	0	0	0	2,875
NO_x	0	0	0	1,189	322	0	0	0	0	1,511
HC	0	0	0	500	46	0	0	0	0	546
Emissions Rates (g/veh.-mile)										
CO	0	0	0	19	46	0	0	0	0	
NO_x	0	0	0	9	7	0	0	0	0	
HC	0	0	0	4	6	0	0	0	0	

TABLE 7

ULTIMATE LINE SOURCE EMISSIONS
(FUNCTIONAL CLASS - FREEWAYS)

Attributes: Special Topography: not present
Capacity Alterations: all categories
Sensitive Land Use: not present


MISSISSIPPI
RIVER
ST CHARLES
ST LOUIS
MISSOURI
RIVER
MERAMEC
RIVER
ST. LOUIS CO.
JEFFERSON CO.
MADISON CO.
ST CLAIR CO.
ST CLAIR CO.
MONROE CO.

NORTH
GRAPHIC SCALE IN MILES
SYSTEM 7061

FIGURE 17

ULTIMATE LINE SOURCES
(FUNCTIONAL CLASS-FREEWAYS)
Attributes: Special Topography: all categories
Capacity Alterations: all categories
Sensitive Land Use: not present

ADT Ranges (Thousands)	
30-35	▤
35-40	≈
40-45	• • • •
45-50	⋈
50-55	▬
55-60	∴∴
60-65	○○○
65-70	●●●
70-200	■

ADT Ranges (Thousands)

	30-35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-200	Total
VMT (24 hours)	29,475	122,582	22,373	0	0	180,470	16,210	256,155	320,842	948,107
Emissions (kilograms/24-hour period)										
CO	532	2,247	558	0	0	3,648	410	10,295	16,091	33,781
NO_x	269	1,112	172	0	0	1,562	124	1,876	2,084	7,199
HC	108	453	96	0	0	697	70	1,400	2,016	4,840
Emissions Rates (g/veh.-mile)										
CO	18	18	25	0	0	20	25	40	50	
NO_x	9	9	8	0	0	9	8	7	6	
HC	4	4	4	0	0	4	4	5	6	

TABLE 8

ULTIMATE LINE SOURCE EMISSIONS
(FUNCTIONAL CLASS-FREEWAYS)
Attributes: Special Topography: all categories
Capacity Alterations: all categories
Sensitive Land Use: not present

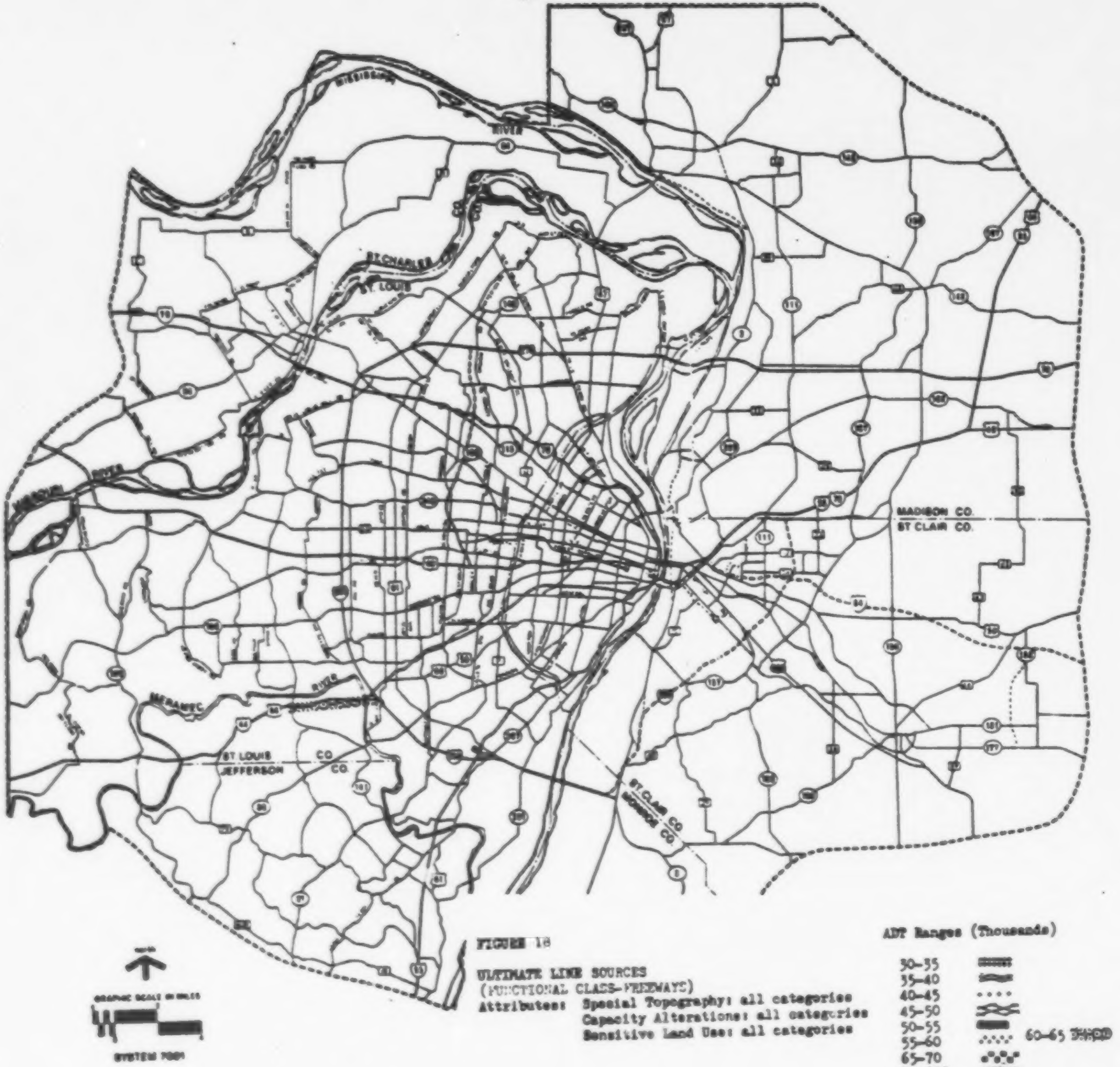

MISSISSIPPI
RIVER
ST CHARLES
ST. LOUIS
MISSOURI RIVER
MADISON CO.
ST CLAIR CO.
MERAMEC
RIVER
ST LOUIS CO.
JEFFERSON CO.
ST CLAIR CO
MONROE CO.
NORTH
GRAPHIC SCALE IN MILES
SYSTEM 7001
ADT Ranges (Thousands)
30–35
35–40
40–45
45–50
50–55
55–60
60–65
65–70
70–200

FIGURE 18

ULTIMATE LINE SOURCES
(FUNCTIONAL CLASS-FREEWAYS)
Attributes: Special Topography: all categories
Capacity Alterations: all categories
Sensitive Land Use: all categories

ADT Ranges (Thousands)

	30-35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-200	Total
VMT (24 hours)	0	17,589	0	0	0	11,158	267,212	138,132	36,184	470,275
Emissions (kilograms/24-hour period)										
CO	0	666	0	0	0	551	5,833	4,572	972	12,644
NO_x	0	126	0	0	0	71	2,293	1,008	269	3,767
HC	0	94	0	0	0	70	1,071	683	163	2,081
Emissions Rates (g/veh.-mile)										
CO	0	38	0	0	0	49	22	33	27	
NO_x	0	7	0	0	0	6	9	7	7	
HC	0	5	0	0	0	6	4	5	4	

TABLE 9

ULTIMATE LINE SOURCE EMISSIONS
(FUNCTIONAL CLASS-FREEWAYS)
Attributes: Special Topography: all categories
Capacity Alterations: all categories
Sensitive Land Use: all categories

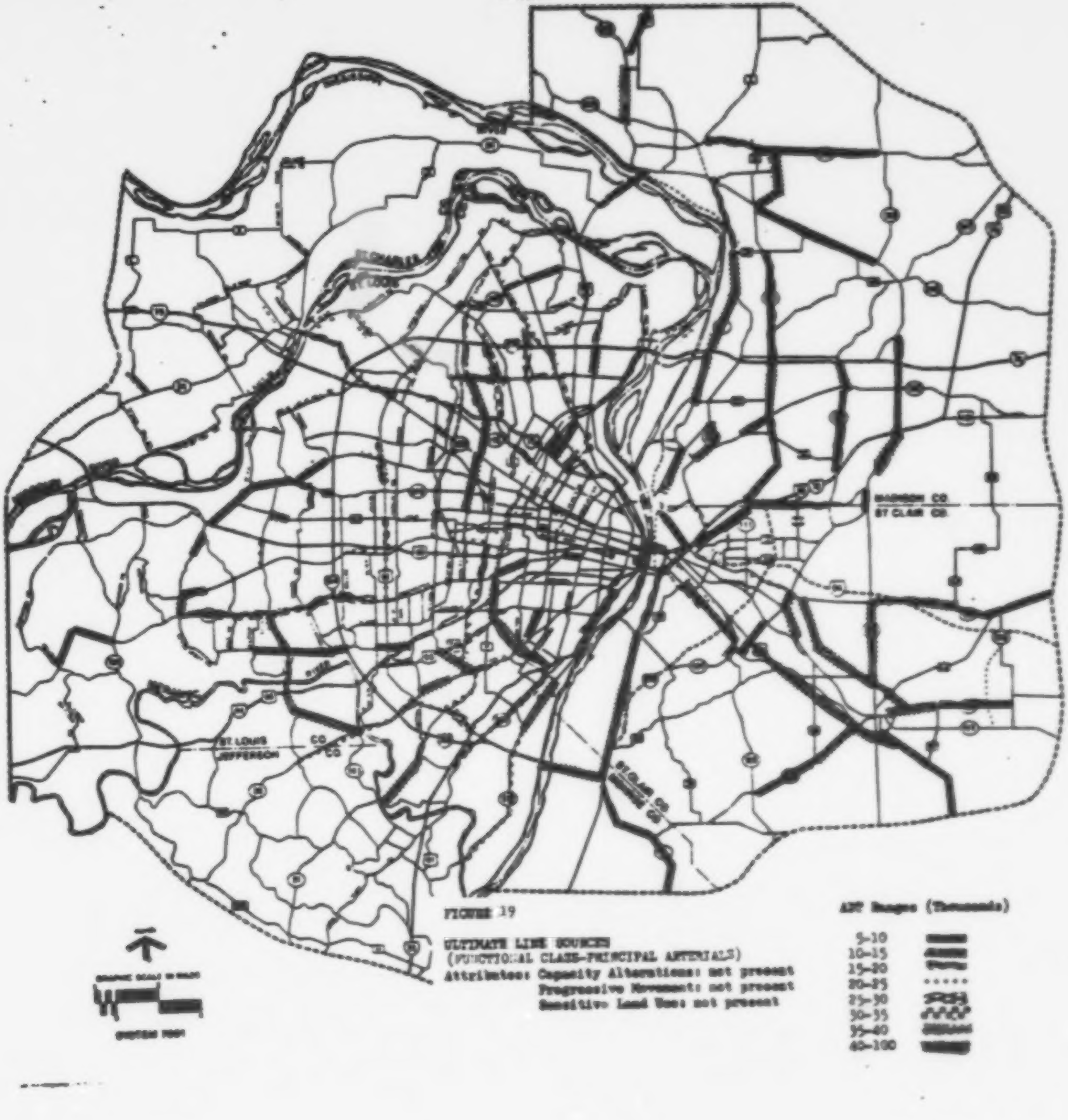

ST CHARLES CO
ST LOUIS
MADISON CO
ST CLAIR CO
ST LOUIS CO
JEFFERSON CO
ST CLAIR CO
MONROE CO
ADT Ranges (Thousands)
5-10
10-15
15-20
20-25
25-30
30-35
35-40
40-100

FIGURE 19

ULTIMATE LINE SOURCES
(FUNCTIONAL CLASS-PRINCIPAL ARTERIALS)
Attributes: Capacity Alterations: not present
Progressive Movement: not present
Sensitive Land Use: not present

	ADT Ranges (Thousands)								
	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-100	Total
VMT (24 hours)	440,668	921,497	643,503	921,216	368,674	246,413	23,179	110,994	3,676,144
Emissions (kilograms/24-hour period)									
CO	14,094	30,530	21,804	31,373	14,326	12,140	728	4,974	129,969
NO_x	2,522	5,234	3,655	5,237	2,057	1,341	133	607	20,786
HC	2,178	4,634	3,267	4,680	1,995	1,500	113	645	19,012
Emissions Rate (grams per veh.-mile)									
CO	32	33	34	34	39	49	31	45	
NO_x	6	6	6	6	6	5	6	5	
HC	5	5	5	5	5	6	5	6	

TABLE 10

ULTIMATE LINE SOURCE EMISSIONS
(FUNCTIONAL CLASS-PRINCIPAL ARTERIALS)
Attributes: Capacity Alterations: not present
Progressive Movement: not present
Sensitive Land Use: not present

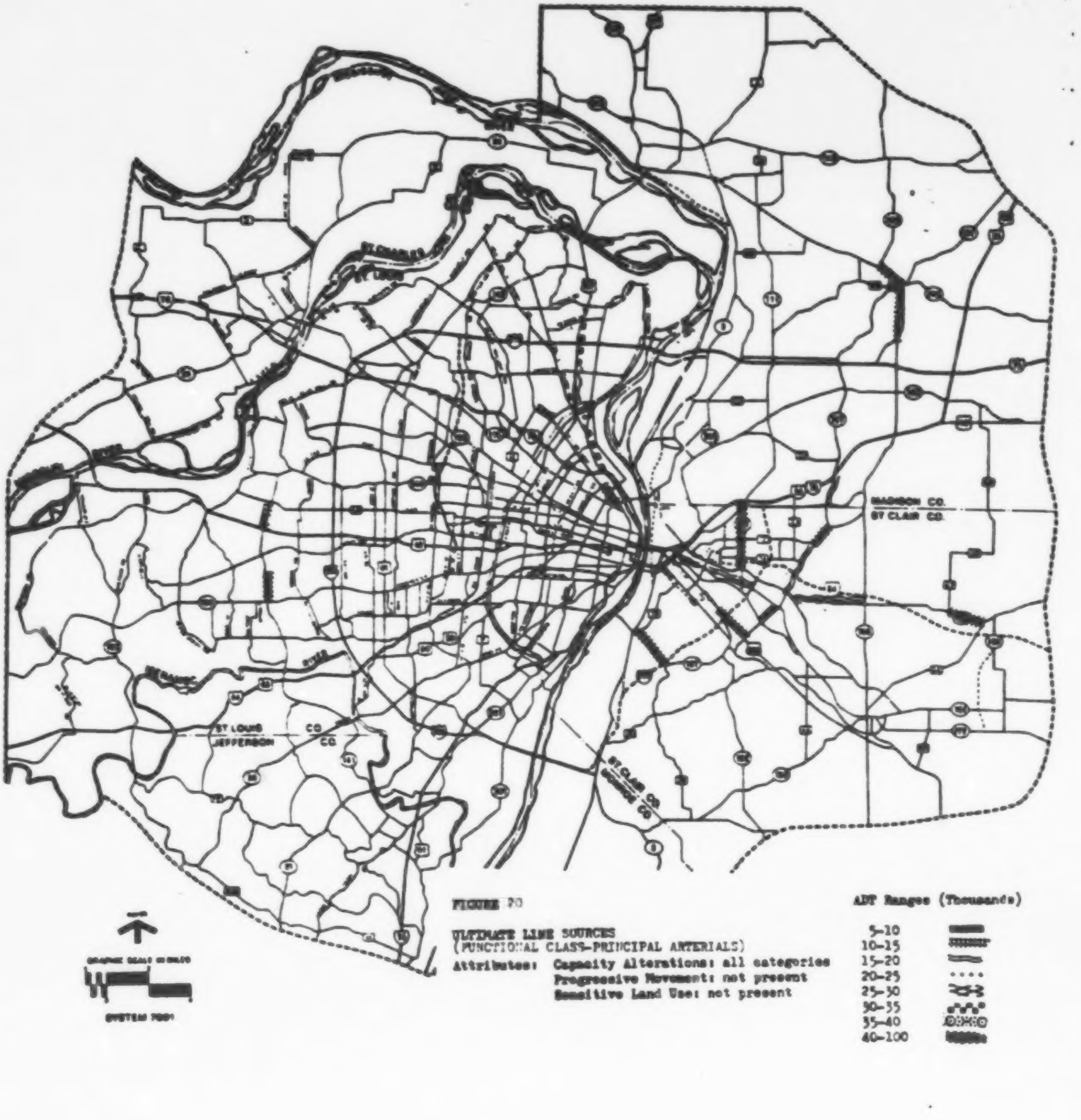

ST CHARLES
ST LOUIS
MADISON CO.
ST CLAIR CO.
ST LOUIS CO.
JEFFERSON CO.
ST CLAIR CO.
MONROE CO.
SYSTEM 7001

FIGURE 70

ULTIMATE LINE SOURCES
(FUNCTIONAL CLASS-PRINCIPAL ARTERIALS)

Attributes: Capacity Alterations: all categories
Progressive Movement: not present
Sensitive Land Use: not present

ADT Ranges (Thousands)	
5–10	▬
10–15	▤
15–20	═
20–25	• • • •
25–30	≈
30–35	∘∘∘
35–40	◎
40–100	■

ADT ranges which have attributes of capacity alteration, but no progressive movement or sensitive land use. Emissions from the link subset are summarized in Table 15. Figure 25 depicts those minor arterial links in various ADT ranges which have attributes of capacity alteration and progressive movement, but no sensitive land use attributes. Table 16 summarizes these particular emissions. Finally, there are no minor arterial links in various ADT ranges which have all the attributes of capacity alteration, progressive movement, and sensitive land use. The synthesis of all possible component attribute groups over all functional classes represents the most refined and accurate level of line source definition for the St. Louis Air Quality Control Region on the basis of current network data. Discussion of the implications of this synthesis will occur in the immediately following section.

D. Synthesis of Line Source Information

The synthesis of 24-hour detailed definition and description of line source information provided by NETSEN, and their resulting emissions computations from SAPOLLUT is shown in Table 17. The aggregate network of line sources encompasses approximately 1,370 miles of roadway, with a total of nearly 17 million vehicle miles of travel daily. Approximately 45% of this VMT exposure occurs on freeways, 44% on principal arterials, and the remaining 11% on minor arterials. In terms of mileage, 195 miles is composed of freeway line sources, representing the freeway corridors of the region, and the principal and minor arterials comprise the remaining 1,175 miles of line sources. The aggregate 24-hour emissions are 482,322 kg. of CO,117,109 kg. of NO_x and 76,777 kg. of HC. A component analysis in Table 18 shows that

ADT Ranges (Thousands)

	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-100	Total
VMT (24 hours)	25,200	160,958	112,732	157,693	82,300	88,483	10,950	0	638,316
Emissions (kilograms/24-hour period)									
CO	829	5,464	4,191	5,994	3,166	3,408	362	0	23,414
NO_x	143	906	627	870	460	493	62	0	3,561
HC	127	822	599	850	443	478	55	0	3,374
Emissions Rate (grams per veh.-mile)									
CO	33	34	37	38	38	39	33	0	
NO_x	6	6	6	6	6	6	6	0	
HC	5	5	5	5	5	5	5	0	

TABLE 11

ULTIMATE LINE SOURCE EMISSIONS
(FUNCTIONAL CLASS-PRINCIPAL ARTERIALS)
Attributes: Capacity Alterations: all categories
Progressive Movement: not present
Sensitive Land Use: not present

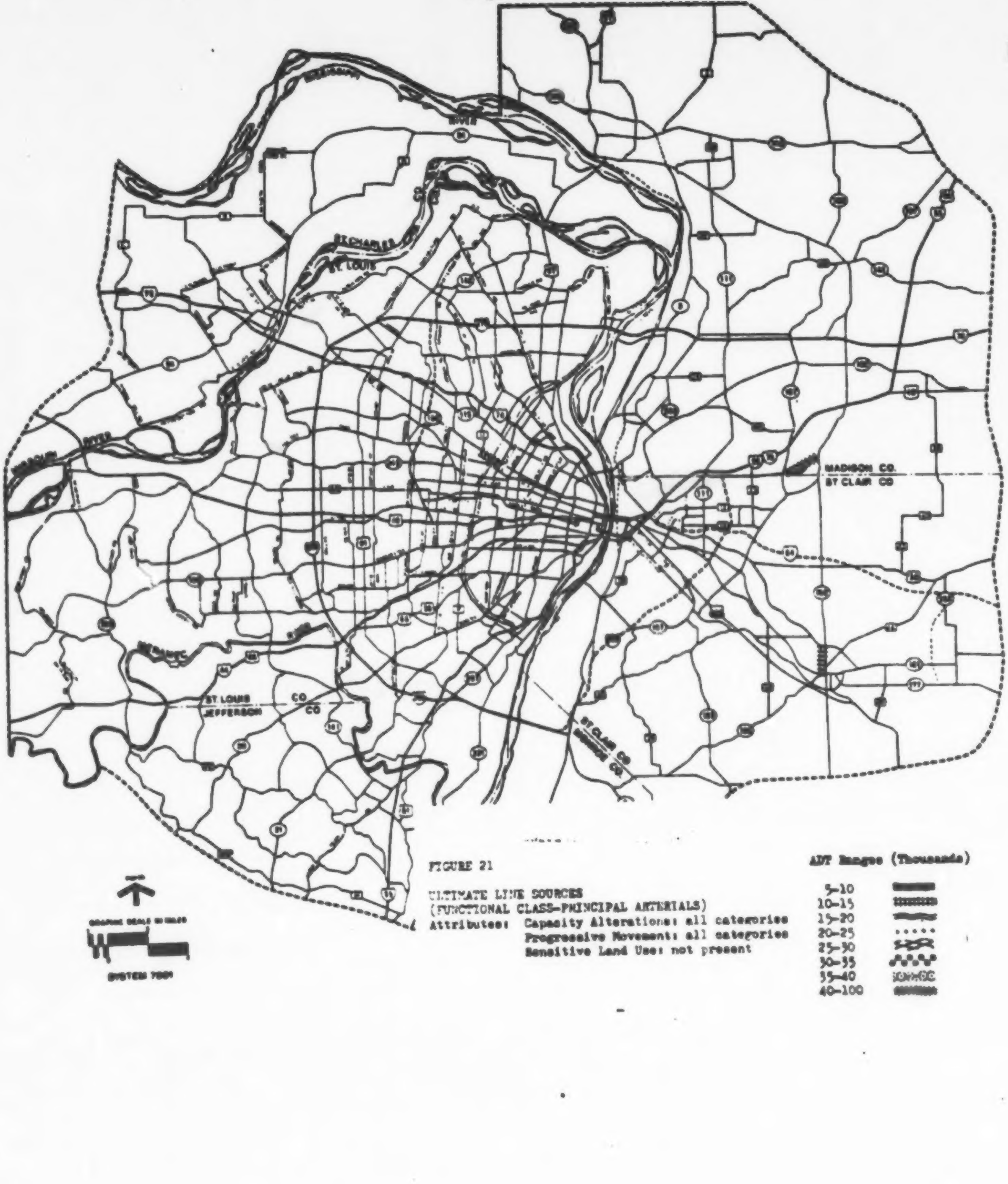

ST CHARLES CO
ST LOUIS
MISSOURI RIVER
MADISON CO.
ST CLAIR CO
MERAMEC
ST LOUIS CO
JEFFERSON CO
ST CLAIR CO
MONROE CO
GRAPHIC SCALE IN MILES
SYSTEM 7001
ADT Ranges (Thousands)
5-10
10-15
15-20
20-25
25-30
30-35
35-40
40-100

FIGURE 21

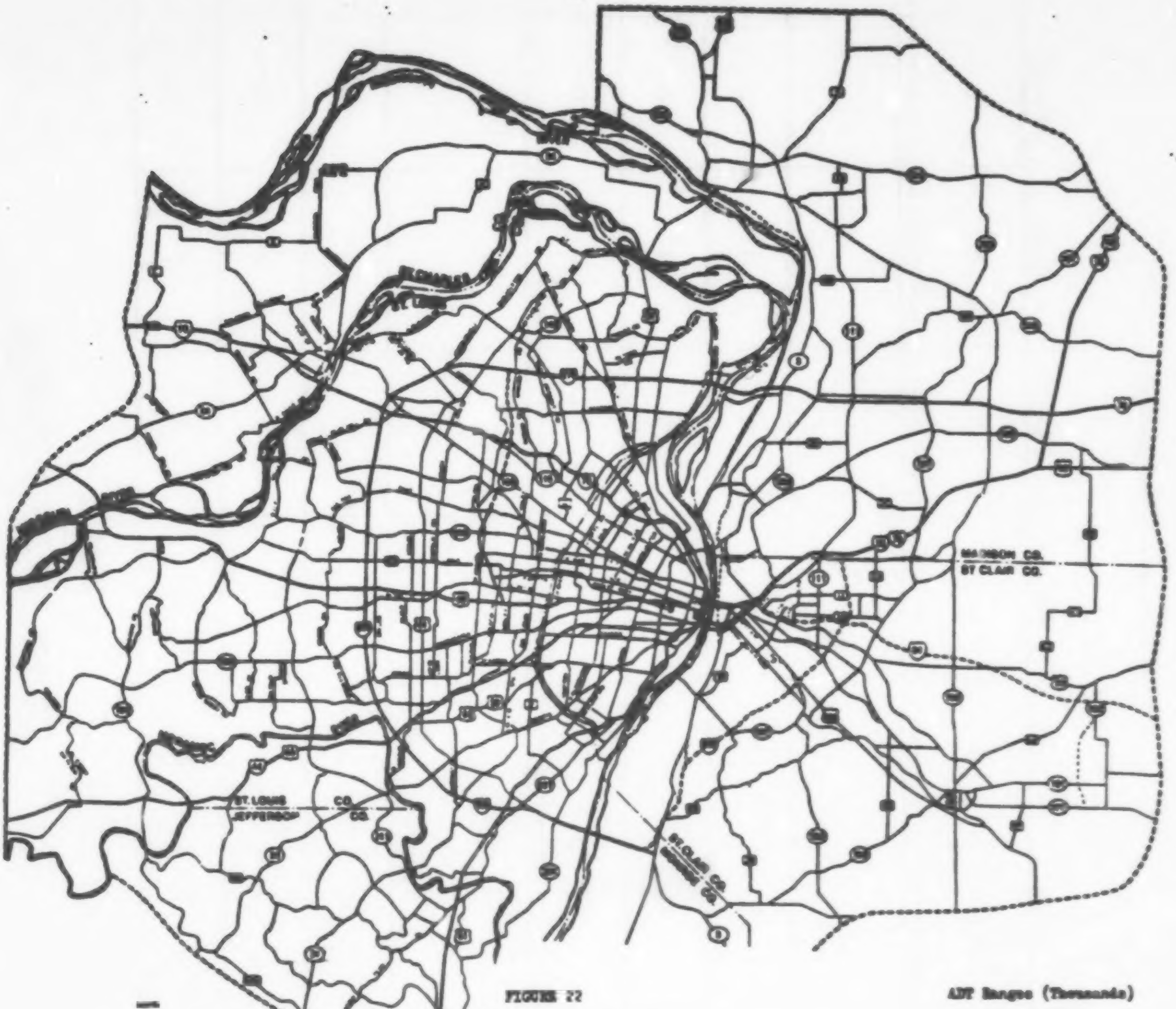
ULTIMATE LINE SOURCES
(FUNCTIONAL CLASS-PRINCIPAL ARTERIALS)
Attributes: Capacity Alterations: all categories
Progressive Movement: all categories
Sensitive Land Use: not present

ADT Ranges (Thousands)

	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-100	Total
VMT (24 hours)	0	38,160	17,780	0	46,867	40,470	0	0	143,277
Emissions (kilograms/24-hour period)									
CO	0	1,245	841	0	1,748	1,624	0	0	5,458
NO_x	0	217	96	0	261	225	0	0	799
HC	0	191	106	0	250	223	0	0	770
Emissions Rate (grams per veh.-mile)									
CO	0	33	47	0	37	40	0	0	
NO_x	0	6	5	0	6	6	0	0	
HC	0	5	6	0	5	5	0	0	

TABLE 12

ULTIMATE LINE SOURCE EMISSIONS
(FUNCTIONAL CLASS-PRINCIPAL ARTERIALS)
Attributes: Capacity Alterations: all categories
Progressive Movement: all categories
Sensitive Land Use: not present


MADISON CO.
ST CLAIR CO.
ST. LOUIS CO.
JEFFERSON CO.
ST CLAIR CO.
MONROE CO.
ST CHARLES
ST LOUIS

NORTH
GRAPHIC SCALE IN MILES
SYSTEM MAP

FIGURE 22

ULTIMATE LINE SOURCES
(FUNCTIONAL CLASS-PRINCIPAL ARTERIALS)
Attributes: Capacity Alterations: all categories
Progressive Movement: all categories
Sensitive Land Use: all categories

ADT Ranges (Thousands)
5-10
10-15
15-20
20-25
25-30
30-35
35-40
40-100

ADT Ranges (Thousands)

	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-100	Total
VMT (24 hours)	0	8,240	0	0	0	0	0	0	8,240
Emissions (kilograms/24-hour period)									
CO	0	277	0	0	0	0	0	0	277
NO_x	0	46	0	0	0	0	0	0	46
HC	0	42	0	0	0	0	0	0	42
Emissions rate (grams per veh.-mile)									
CO	0	34	0	0	0	0	0	0	
NO_x	0	6	0	0	0	0	0	0	
HC	0	5	0	0	0	0	0	0	

TABLE 13

ULTIMATE LINE SOURCE EMISSIONS
(FUNCTIONAL CLASS-PRINCIPAL ARTERIALS)
Attributes: Capacity Alterations: all categories
Progressive Movement: all categories
Sensitive Land Use: all categories

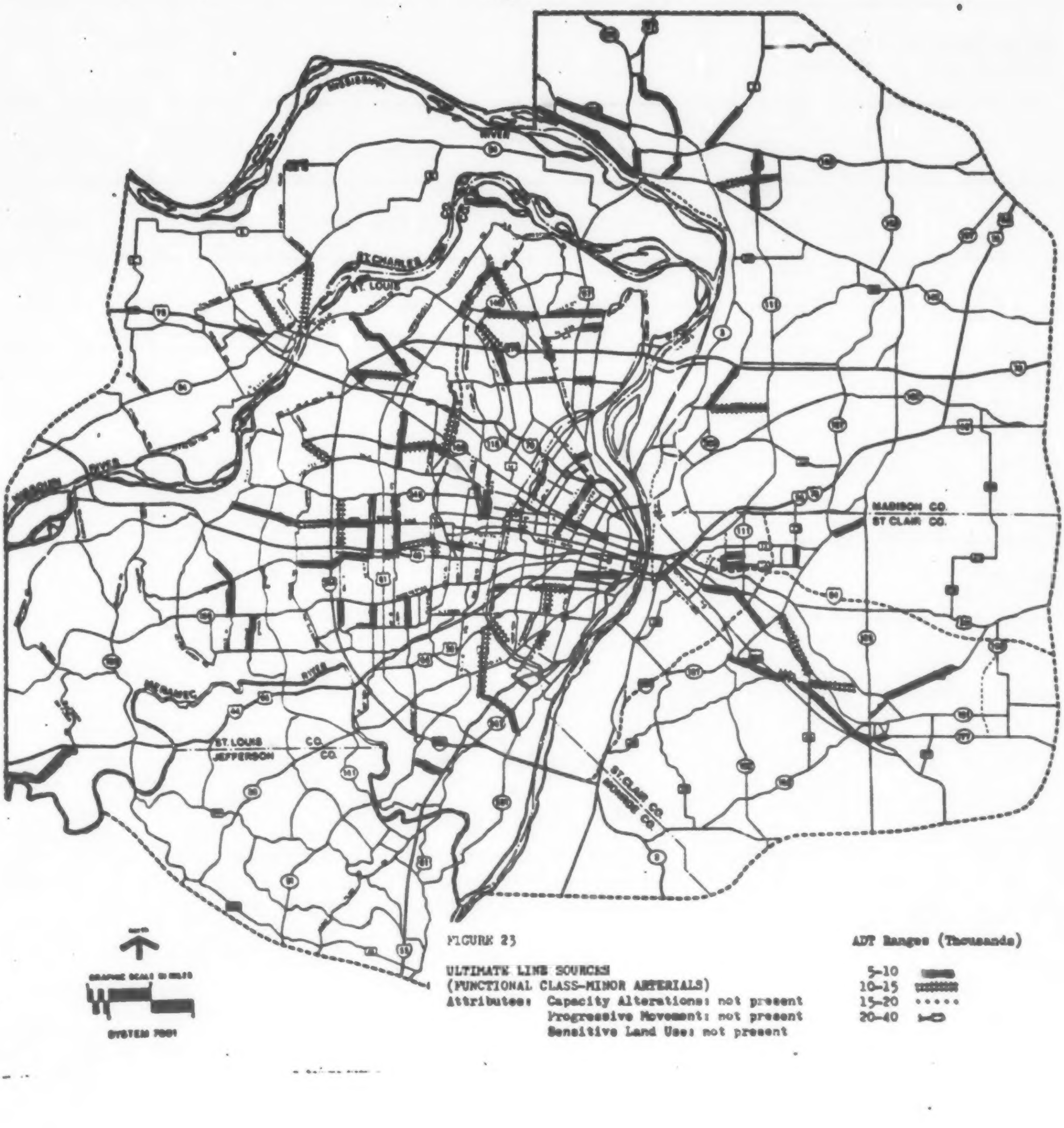

MISSISSIPPI
RIVER
ST CHARLES
ST LOUIS
MISSOURI RIVER
MERAMEC
RIVER
MADISON CO.
ST CLAIR CO.
ST LOUIS CO.
JEFFERSON CO.
ST CLAIR CO.
MONROE CO.
NORTH
GRAPHIC SCALE IN MILES

FIGURE 23

ULTIMATE LINE SOURCES
(FUNCTIONAL CLASS-MINOR ARTERIALS)
Attributes: Capacity Alterations: not present
Progressive Movement: not present
Sensitive Land Use: not present

ADT Ranges (Thousands)

5-10 ▬
10-15 ▨
15-20 • • • • •
20-40 ⊸

ADT Ranges (Thousands)

	5-10	10-15	15-20	20-40	Total
VMT (24 hours)	539,917	488,099	218,731	90,525	1,377,272
Emissions (kilograms/24-hour period)					
CO	18,020	16,144	9,043	4,357	47,564
NO_x	3,078	2,772	1,216	488	7,554
HC	2,717	2,455	1,218	547	6,937
Emissions Rates (g/veh.-mile)					
CO	33	33	41	48	
NO_x	6	6	6	5	
HC	5	5	6	6	

TABLE 14

ULTIMATE LINE SOURCE EMISSIONS
(FUNCTIONAL CLASS-MINOR ARTERIALS)
Attributes: Capacity Alterations: not present
Progressive Movement: not present
Sensitive Land Use: not present

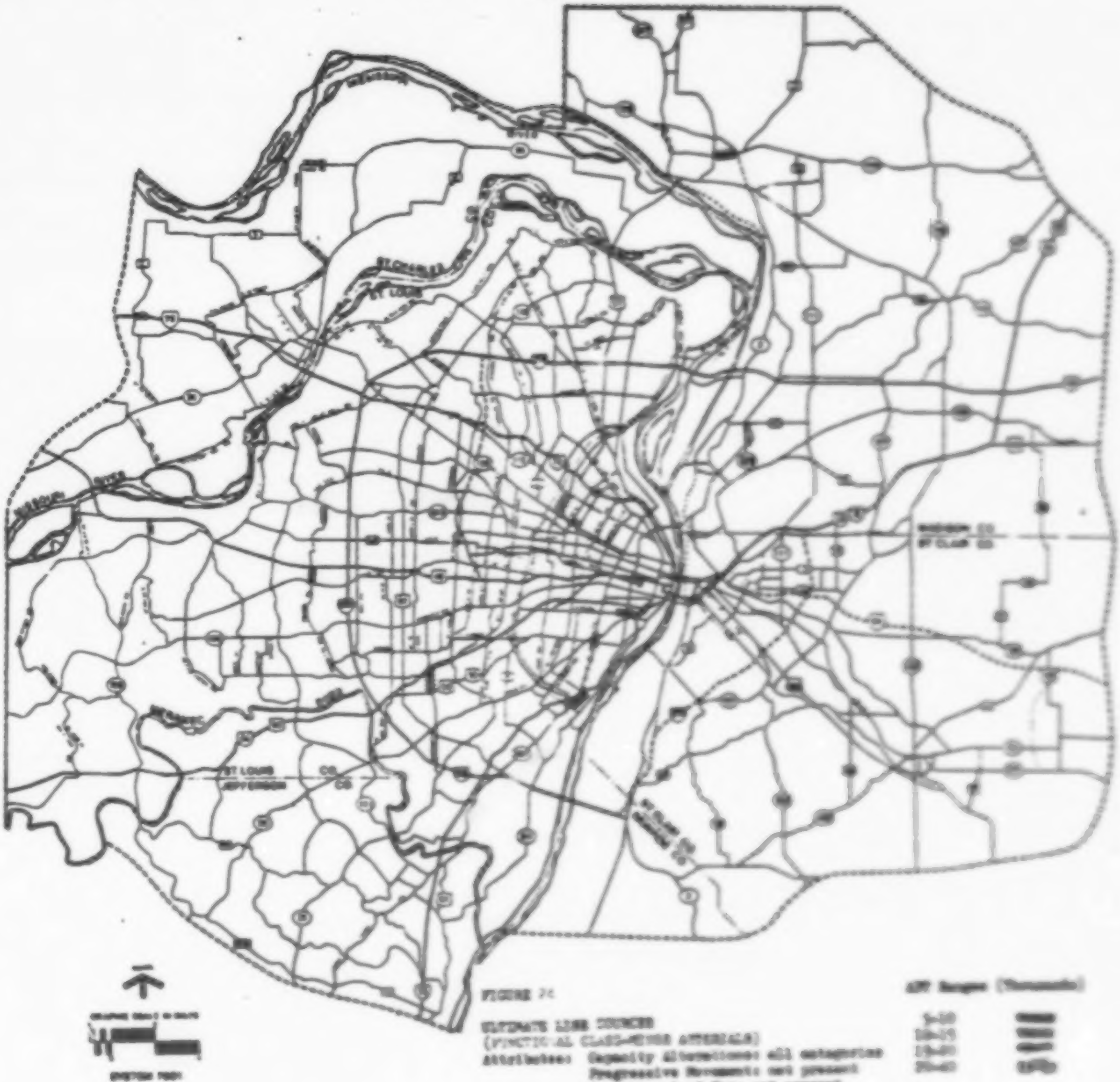

MISSOURI RIVER
ST CHARLES CO
ST LOUIS
MADISON CO
ST CLAIR CO
ST LOUIS CO
JEFFERSON CO
MERAMEC RIVER
ST CLAIR CO
MONROE CO
GRAPHIC SCALE IN MILES
SYSTEM 1990

FIGURE 74

ULTIMATE LINK COUNTS
(FUNCTIONAL CLASS—MINOR ARTERIALS)
Attributes: Capacity Alternatives: all categories
Progressive Movement: not present
Sensitive Land Use: not present

ADT Ranges (Thousands)	
5-10	▬
10-15	▬
15-20	▬
20-40	▬

ADT Ranges (Thousands)

	5-10	10-15	15-20	20-40	Total
VMT (24 hours)	18,032	24,161	81,595	33,458	157,246
Emissions (kilograms/24-hour period)					
CO	575	839	2,944	1,985	6,343
NO_x	103	135	455	175	868
HC	89	125	430	227	871
Emissions Rates (g/veh.-mile)					
CO	32	35	36	59	
NO_x	6	6	6	5	
HC	5	5	5	7	

TABLE 15

ULTIMATE LINE SOURCE EMISSIONS
(FUNCTIONAL CLASS-MINOR ARTERIALS)
Attributes: Capacity Alterations: all categories
Progressive Movement: not present
Sensitive Land Use: not present

ADT Ranges (Thousands)

	5-10	10-15	15-20	20-40	Total
VMT (24 hours)	0	16,947	19,080	61,305	97,332
Emissions (kilograms/24-hour period)					
CO	0	622	624	2,935	4,181
NO	0	93	108	315	516
HC	0	90	96	373	559
Emissions Rates (g/veh.-mile)					
CO	0	37	33	48	
NO	0	6	6	5	
HC	0	5	5	6	

TABLE [illegible]

[illegible] LINE SOURCE EMISSIONS
(FUNCTIONAL CLASS—MINOR ARTERIALS)
attributes: Capacity Alterations: all categories
Progressive Movement: all categories
Sensitive Land Use: not present

freeway line sources consistently contribute 30-60% to totals in all emission types, with typically 50% of total contribution emanating from arterial sources, and typically near 12% being contributed from minor arterial operations. These percentages correlate closely with the logic of discussion of emission stimuli of average speed and VMT referred to in Chapter I, and component analytic discussions earlier in this immediate chapter. The average rates are aggregates over all ADT ranges considered in each of the specific functional classes under study. They show a disturbing stability across all functional classes, essentially due to the aggregation and averaging of specific V/C, average speed and VMT ranges such as those displayed in Tables 6 through 16. The research team feels that more meaningful and accurate rates exist at the disaggregate levels such as those shown in Tables 6 through 16 where rates specific to ADT ranges for particular components of the line sources containing specific attributes are exhibited.

E. Related Processing Costs

The traffic emissions software system developed herein is a series of eight basic programs coupled to a variable number of utility programs. Two of the eight basic programs are run only once. As such, this discussion will deal only with the remaining six involved in software processing with [illegible]. It is theoretically possible to make 55 separate runs of the system under one batch [illegible], however, only four runs were made in one job for the duration of the project, in order to facilitate turn around time. A [illegible] fixed cost figure for one run through the system which produced emissions on only line link would be approximately $[illegible]. This cost represents [illegible] system overhead and individual

	Functional Class			
	Freeway	Principal Arterials	Minor Arterials	Totals
Total VMT* (24 hours)	7,594,134	7,448,789	1,718,014	16,760,937
Total Emissions (kilograms/24-hour period)				
CO	155,128	264,845	62,349	482,322
NO_x	65,482	41,971	9,656	117,109
HC	29,525	38,245	9,007	76,777
Average Rate of Emissions (g./vehicle-mile)				
CO	20	36	36	
NO_x	9	6	6	
HC	4	5	5	

*For all links with volumes reported.

TABLE 17

SUMMARY OF ULTIMATE LINK SOURCE EMISSIONS INFORMATION

Percent Contribution	Freeway	Principal Arterials	Minor Arterials	Total
CO	32%	55%	13%	100%
NO_x	56%	36%	8%	100%
HC	38%	50%	12%	100%

TABLE 18

PERCENTAGE OF TOTAL EMISSIONS CONTRIBUTED BY FUNCTIONAL CLASS OF LINE SOURCE program overhead costs. Due to the rather large number of combinations of link attributes which may be tested for, results of using the system on the St. Louis Air Quality Control Region yield a typical maximum cost for one pass of $8.00, with an average cost of $5 to $6. Table 19 illustrates a typical run of the system showing time requirement, percentage of total time, and the amount of main core storage required for each program. It is interesting to note that SAPOLLUT required only 34.5% of all Central Processing Unit (CPU) time. The cost of the run is computed on the rate shown, and charges for lines printed (approximately $1 per run) should be added to the CPU time cost. If four or more passes through the system are made, which is typical of the operating rationale used in the performance of the research on the St. Louis Air Quality Control Region, the cost drops to $6.30 due to the spreading of overhead costs over several runs. It is felt this cost figure is quite tolerable, given the level of detail possible for examining the network, and the nominal number of runs required to synthesize information over all functional highway classes. All figures are for an IBM S/360 Model 65 machine.

F. Limited Sensitivity Analysis

Limited amount of sensitivity analyses were performed subsequent to the definition of line sources, to examine gross changes in the supply of highway facilities and resultant alterations of traffic flow and emissions. Two separate analyses relating to 24-hour periods were performed,

Program	CPU* Time	%	Core Required**
NETSEN	8.59	20.7	60
RUMMY	1.87	4.5	46
BUILDHR	4.25	10.2	82
PRINTHR	7.60	18.3	40
HRMOD	1.82	4.4	42
SAPOLLUT	14.35	34.5	60
MISC. UTILITIES	3.06	7.4	34
TOTALS	41.54	100.0	

*Central Processing Unit, in seconds
**in K's (1024 bytes)
***All Freeways, 145 links

TABLE 19

COST SUMMARY FOR TYPICAL SOFTWARE SYSTEM RUN*** typical of near-term alteration of emissions estimates which might occur as typical modification of corridor facilities occurs in one case, requiring the placement of total corridor loads onto other corridors in the region during construction alterations. In the second case, a badly needed distributor facility is completed, as highway planning is brought progressively to the implementation and completion phase, yielding resulting diversion of presently congested crosstown flows onto the new high-type design facility.

The first analysis was the examination of emissions performance resulting from the deletion of availability of a freeway corridor and the resultant loading of the displaced traffic onto two adjacent freeways. This was performed through deletion of I-44 from I-55 to I-244. An average ADT was taken for I-44 and half of this was loaded onto each link of I-55 from I-44 to I-244 and the remaining half onto each link of U.S. 40 from I-55 to I-244. Figure 26 shows the location of these three freeways. Table 20 summarizes original VMT's and emissions on each freeway and their aggregate. It should be noted that because of limitations in FHWA Battery program BUILDER, only a maximum ADT of 99,999 can be used. Therefore, since some links on U.S. 40 are either currently near or over 100,000 ADT, or would exceed 100,000

[illegible]

[illegible]

[illegible]

Freeway

	I-55 Original	I-44 Original	U.S. 40 Original	Total Original Facilities	I-55, U.S. 40 with Diversion
VMT (24 hours)	789,093	718,290	1,092,[illegible]97	2,599,980	2,502,875
Emissions (kilograms/24-hour period)					
CO	17,763	15,131	24,[illegible]73	57,367	59,534
NO_x	6,452	6,070	8,[illegible]87	21,509	19,982
HC	3,220	2,834	4,[illegible]46	10,500	10,513
Emissions Rates (g./veh.-mile)					
CO	23	21	22		24
NO_x	8	8	8		8
HC	4	4	4		4

TABLE [illegible]

EMISSIONS SUMMARY FOR FREEWAY CORRIDOR DIVERSION

ADT with diversion, the VMT's for U.S. 40 are underestimates in this sensitivity analysis.

The results reflect the result of eliminating a corridor from use with current traffic loads, or the present impact if I-44 had not been completed. Again, the results are consistent with the literature with respect to impact of increased VMT and lowered average speed as saturation is approached on remaining I-55 and U.S. 40 after diversion. Total CO emissions are higher, total HC emissions are slightly higher, reflecting the above speed and VMT issues, and total NO_x is lower, reflecting impact of lowered operating speeds. Again, the total VMT's shown diverted, and resulting increase in emissions output is understated, due to the FHWA input limitations on ADT discussed above. The aggregate rates have raised slightly for CO, reflecting increased VMT loads on the remaining I-55 and U.S. 40 corridors, however, the lowered average speed component resulting from these flow increases on each corridor have yielded a stable aggregate NO_x rate. The aggregate combinations of altered speeds and changed VMT's over all links of both remaining corridors appeared to have a balancing effect on HC rates, with no apparent aggregate rate change.

The second sensitivity analysis examined the Innerbelt (No. 725) North-South corridor. One component section of this route is complete, and the analysis centered around hypothetically extending it North and South to become an effective North-South Freeway Corridor, and diverting traffic onto it from parallel high volume arterials. Figure 27 illustrates the hypothetical Innerbelt Freeway and the parallel arterials under study. The analysis consisted of diverting 50% of the traffic off each arterial and placing it on the Innerbelt. Baseline

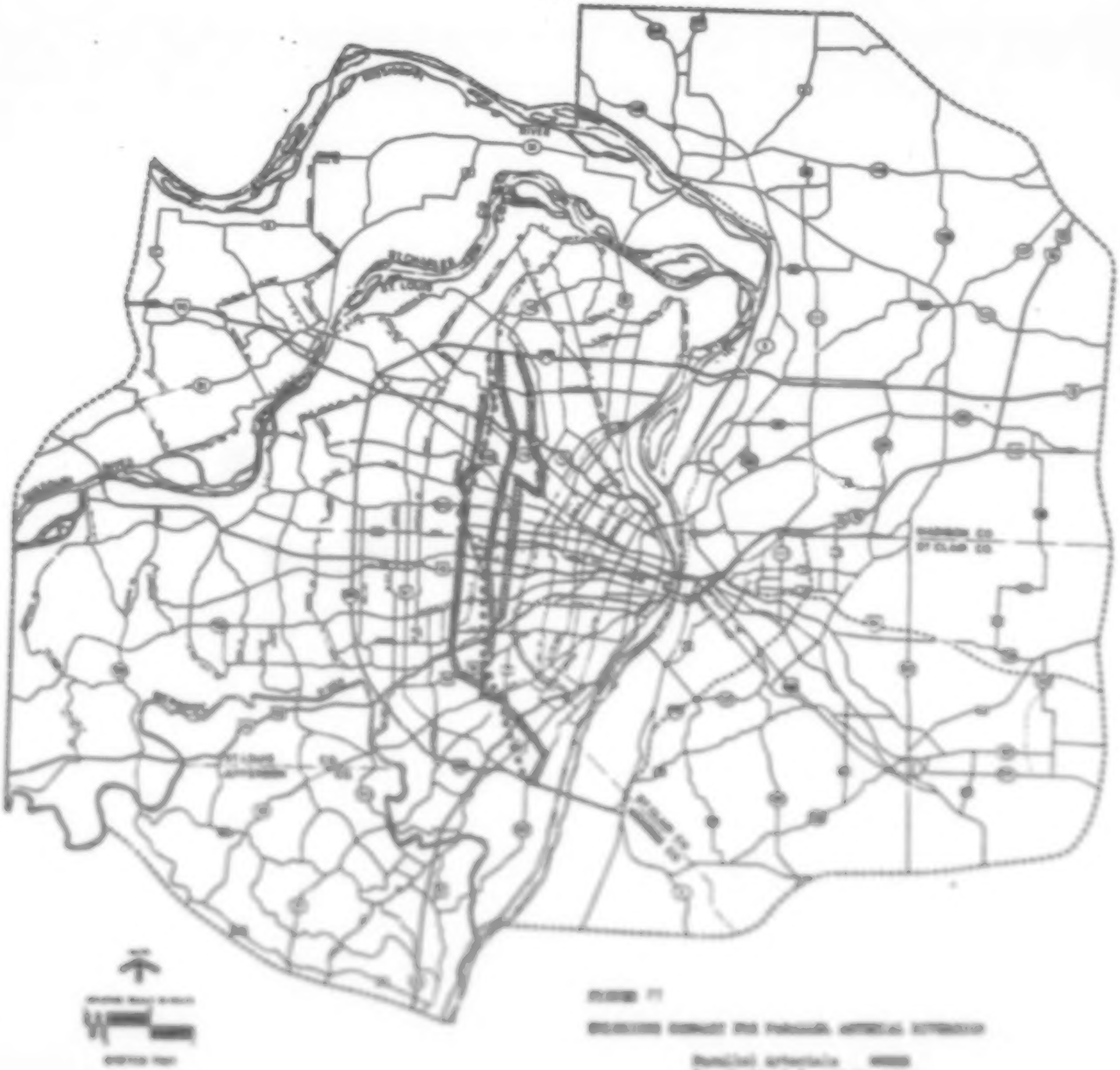

MISSOURI RIVER
ST. CHARLES CO.
ST. LOUIS CO.
MADISON CO.
ST. CLAIR CO.

FIGURE [illegible]

[illegible] [illegible] FOR PARALLEL ARTERIAL [illegible]

Parallel Arterials ▬▬
Hypothetical [illegible] • • •

Routes

	(1) Parallel Arterials before Diversion	(2) Parallel Arterials after Diversion	(3) Hypothetical Innerbelt	(2) + (3)
VMT (24 hours)	451,042	220,896	261,992	482,888
Emissions (kilograms/24-hour period)				
CO	15,513	6,811	5,079	11,890
NO_x	2,565	1,279	2,312	3,591
HC	2,299	1,069	993	2,062
Emissions Rates (g./veh.-mile)				
CO	34	31	19	25
NO_x	6	6	9	7
HC	5	5	4	4

TABLE 21

EMISSIONS SUMMARY FOR
PARALLEL ARTERIAL DIVERSION

runs were made of arterial street emissions before and after diversion, and the hypothetical presently loaded Innerbelt. Table 21 summarizes the results of this sensitivity analysis. Present provision of the new freeway corridor facility, in light of current parallel arterial operations, yields a drop in total emissions of CO and HC, when compared to operation of arterials alone in column 1. Again, this is due to diversion of part of the aggregate traffic load to a facility with higher average speeds. Likewise, this increase in speed yields higher total NO_x emissions. The rates on the Innerbelt, given the constancy of total VMT and provision of higher operating speeds, have dropped as expected for CO and HC, and increased slightly for NO_x, when compared to arterial rates before diversion.

CHAPTER V

CONCLUSION

In concluding the reported research, it is relevant to point out the capabilities and information which have been provided, comment on further needed research to advance the state of the art, and discuss the general status of line source emissions modelling with respect to current knowledge about related traffic engineering phenomena.

A. Use and Applicability of Present Research and Modelling Results

The data analysis, model development, and integration with SAPOLLUT has yielded several tangible outputs. They are:

1.) A complete quantitative and relevant qualitative data base for freeways, principal arterials and minor arterials in the St. Louis Air Quality Control Region.

2.) A model format - NETSEN - which is capable of sorting and describing any subset of components of the above traffic network, at continually varying levels of detail, from gross geographic description of volumes only, to highly refined geographic locations possessing multiple attributes of traffic, geometric design, topographic, control and land use conditions which are significant in the link's operation and its relationship to emissions and/or air quality.

3.) The interface of the above format with the present operating rationale of SAPOLLUT, thus yielding the capability to model and describe the total emissions of CO, NO_x and HC emanating from a network described at a desired level of attributes, which have been used as input to NETSEN.

4.) Based on the most refined use of the above in the St. Louis Area, an extremely accurate statement of the line sources. This statement encompasses the sources, descriptions, attributes and total emissions resulting from 1,370 miles of roadway, composed of 195 miles of freeways, and 1,175 miles of principal and minor arterials. The complete description and discussion of these line sources is contained in Chapter IV.

5.) A capability to perform link by link sensitivity analysis on the types of attributes existing on one individual link, a corridor of several links, or an area of several individual street links. Thus, design characteristics and/or traffic loads may be altered or eliminated, for purposes of using SAPOLLUT to yield the resulting changes in aggregate emissions.

B. Recommendations for Further Research

As is expected from intensive research on any problem, the activities of data collection, logic development and model construction of NETSEN, and construction of its interface with SAPOLLUT, have yielded some insights into current gaps in the state of the art of merging information on the traffic and network phenomena with present emissions modelling. As such, several specific items represent areas of new or improved research focus which the research team feels should be pursued in future activity on this topic. They are:

1.) Future use of a model such as SAPOLLUT for basic research on current emissions behavior should be pursued in a highly different software format than SAPOLLUT currently employs. Specifically:

a.) Use of any format requiring a loaded assignment network, including assignment on present networks should not be considered due to:

1.) The complexities of intermediate software.

2.) The theoretical issues surrounding the validity of assignment model forecast volumes, or assignment model loaded volumes on the present network vs. current ground count data. This is particularly relevant in the St. Louis Area at this time, due to vague relationships of assignment output vs. actual future foreseeable auto and transit networks in the region, as the comprehensive transportation planning begins a period of revision.

2.) The study team further encourages the development of a capability to use a highly detailed network descriptor model such as NETSEN, with an emissions model which can be interfaced directly with one of the output parameters from NETSEN without requiring an intermediate software battery to change input form. Preferably, the variable input from NETSEN to the emissions model would be a traffic flow theoretic variable having significance to both the tagged links in NETSEN and the emissions computation process.

3.) To this immediate end, it is recommended that NETSEN be run in conjunction with the Modal Emissions Model, which employs speed modes as input to emissions computations.[1] The speed mode concept, as part of the traffic flow theoretic envelope of speed and delay studies, and acceleration noise, it is a relevant and meaningful traffic flow parameter, and can be output as another link descriptor in NETSEN.

4.) Further, appropriate development, collection and use of speed mode or speed profile data should be undertaken by interested professional groups. Such activity is currently underway in the St. Louis Area, through contracts to East-West Gateway from the Federal Highway Administration and the Department of Transportation Systems Center. The activity focuses on driving patterns throughout the metropolitan area and the inherent speed profiles, volumes and spot speeds in such driving patterns. Effort should be directed to matching speed mode and profiles to links with specific groups of attributes, thus facilitating the capability of using speed mode as the critical transfer parameter from NETSEN through emission computations in a Modal Emissions Format. Comprehensive results relating research to speed modes should be possible through use of relevant field collection information to date, synthesized with appropriate use of the literature and flow-theoretic computations.

5.) Development and use of the capability to output emissions information on a link by link mapping is necessary. Current SAPOLLUT output is aggregate emissions by area type and functional class, rendering investigation of emissions intensity and sensitivity analysis somewhat cumbersome at the individual link and corridor level. It appears that employment of the Modal Emissions Model in a manner discussed in the previous paragraphs has the capability of allowing mapping of emissions output at an individual link level over the entire network entered for study.

C. Closing Comments on Status of Line Source-Traffic Attribute Modelling

In final conclusion, effort should be directed toward detailed filtering out of locations of attributes, and measurement of resultant emissions at these link locations, thus cataloging the simultaneous impact of these attributes on emissions. Further, the categorization of traffic operation on facilities should proceed by capturing theoretically sound aspects of flow activity categorized by situation type which are of relevance to emissions, such as queuing and delay descriptions at intersections, and shock wave phenomena on uninterrupted flow links and freeway bottlenecks. Thus, a mapping of network description, refined traffic flow parameters, and emissions will ultimately result, yielding a comprehensive format from which to investigate and calculate emissions.

Footnotes Chapter V

[1] Automotive Exhaust Emissions Modal Analysis Model, EPA No. 460/3-74-005, United States Environmental Protection Agency, Office of Air and Water Control Program, Office of Mobile Source Air Pollution Control, Certification and Surveillance, Ann Arbor, Michigan, January, 1974.

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St. Louis Metropolitan Area Traffic Volume Summary, March 1973-April 1974, Missouri State Highway Department, May 1974.

Traffic Characteristics on Illinois Highways, State of Illinois Department of Transportation, 1972.

Professional Interviews

Bob Weidinger Dave Schmidt	Missouri State Highway Department, Division of Planning, Traffic Section, Jefferson City, Mo.
Donald C. Prinster, Jr.	City of St. Charles, Mo.
Paul Hwang	Geomet, Rockville, Maryland
Dick S. T. Hsu Jack Kretzer Bob Watson	East-West Gateway Coordinating Council, St. Louis, Mo.
Tom Dalton	Chief Traffic Engineer, St. Louis County Division of Highways & Traffic
James F. Baumann	Deputy Traffic Commissioner, City of St. Louis
Frank Kriz Tom Dollous	Missouri State Highway Department, Division of Traffic, District VI Office, Kirkwood, Mo.
Harold Ruffner Fred Bartlesmeyer Ted Ellicott	Illinois Department of Transportation, Traffic Division, East St. Louis District Office
Richard Wilcox Frank Brown	Illinois Department of Transportation, Planning Division, East St. Louis District Office

APPENDIX A

COMPUTER PROGRAM DOCUMENTATION

A-1 NETSEN PROGRAM

NETSEN or Network Sensitivity Program, is designed to receive an input roadway network and, from it, select a subset of the network with certain common characteristics.

The program has two basic inputs, a control card and the data card file. The program begins by reading a control card (illustrated on page 104 of this appendix) which has certain parameters on it for which the program will test the roadway inventory (data cards). The program then moves to a point where the data card is read in. At this point, the program enters a loop, occuring after the last data card is read and tested.

The tests which are performed include a test for ADT, speed difference, truck volumes, and V/C ratio. In testing for these, the user specifies the range for which he wants tested. For example, if the user would like to test ADT for volumes of 0 to 20,000, he enters 0 in ADTLW and 20,000 in ADTHI. For volumes of 19,963 to 23,222 he enters these numbers in the appropriate variables. If the user does not want to test this variable, he enters zeros or blanks in both variables and the program will not perform these tests.

There is one error routine and this is contained in the V/C ratio test. This error routine performs a test on the capacity to make sure it is not zero if a peak hour volume exists. A message will be printed containing node numbers of the link and a statement '***ERROR***, DIVISION BY ZERO'. The program prints the message and then goes to the beginning and reads another data card.

Functional class, special topography, capacity alterations, sensitive land use, and progressive movement are all major variables with many compenent subclassifications within them. For example, functional class FCLSSL includes freeways, principle arterials, minor arterials, collectors and local streets. Each of these can be tested for individually,or in conjunction with some multiples of one. One can test for freeway; freeway and principle arterial; freeway and local and collector, etc. The program also has the ability to not test for any of these by leaving the whole FCLASS (J), J = 1,5 section on the control card blank or coded zeros.

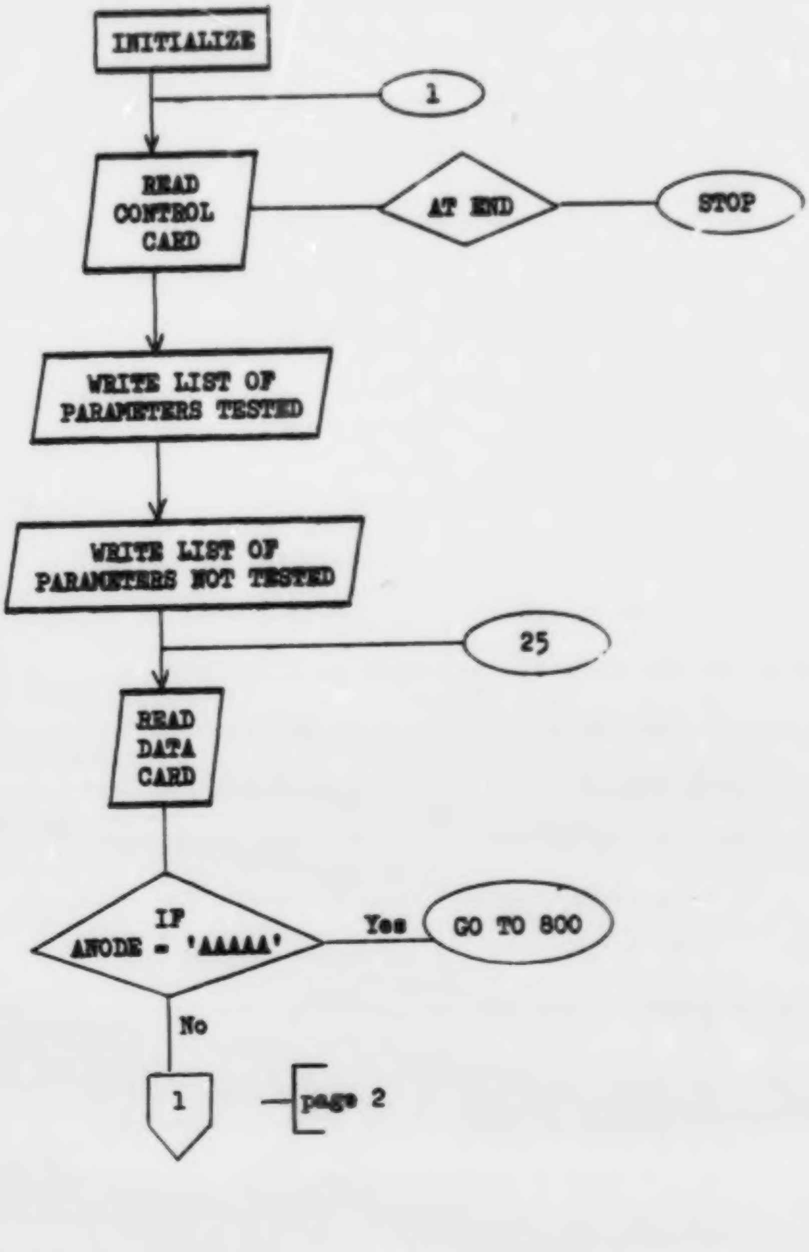
There is also a test for CBD,central business district. If the user wishes to test for CBD on the control card, 1 is entered in the appropriate column. If not, a zero is entered, and the program skips to the next test. When all the tests are performed on a link and it passes, it is written on the line printer and also onto disk or tape.

After the final data card is read, the program rewinds the tape or disk file containing the link records (data card input) and the user has the option to read another control card and start the whole procedure over again. When no more control cards are read in and all testing for the previous control card is complete, the program ends.

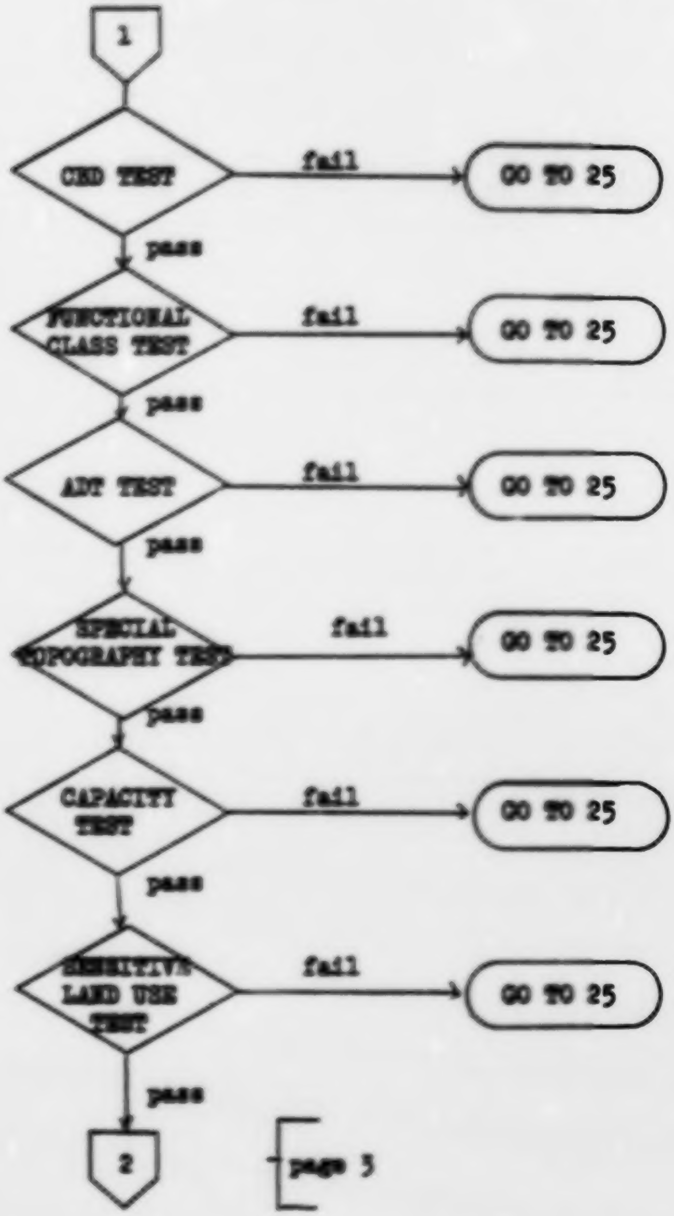
A copy of the output appears as page 122 in this appendix. The output allows the user to have a written record of the parameters tested for along with the node pairs output.

[illegible]

Page 1


INITIALIZE
1
READ CONTROL CARD
AT END
STOP
WRITE LIST OF PARAMETERS TESTED
WRITE LIST OF PARAMETERS NOT TESTED
25
READ DATA CARD
IF ANODE = 'AAAAA'
Yes
GO TO 800
No
1
page 2

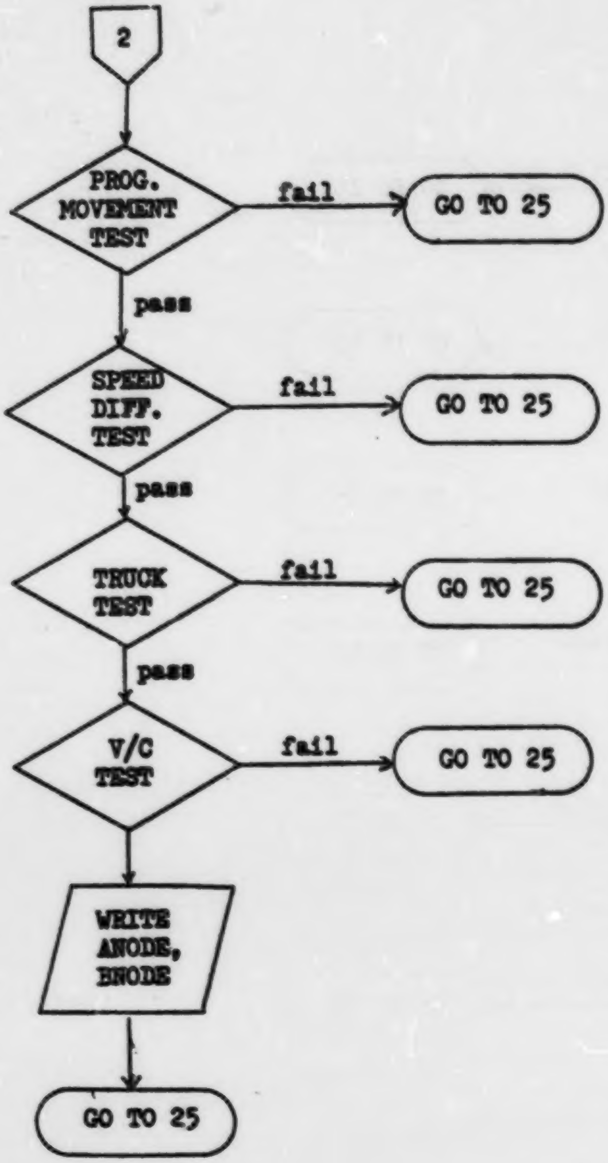
ANNEX

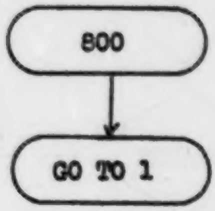

1
CBD TEST
fail
GO TO 25
pass
FUNCTIONAL CLASS TEST
fail
GO TO 25
pass
ADT TEST
fail
GO TO 25
pass
SPECIAL TOPOGRAPHY TEST
fail
GO TO 25
pass
CAPACITY TEST
fail
GO TO 25
pass
SENSITIVE LAND USE TEST
fail
GO TO 25
pass
2

page 3

NETSEN

Page 3


2
PROG. MOVEMENT TEST
fail
GO TO 25
pass
SPEED DIFF. TEST
fail
GO TO 25
pass
TRUCK TEST
fail
GO TO 25
pass
V/C TEST
fail
GO TO 25
WRITE ANODE, BNODE
GO TO 25



INPUT DATA CARD FORMAT: [illegible]

		Variable Name
Col. 1	Blank	
Col. 2-6	Anode Number	ANODE
Col. 7	Anode Leg Number	LEGA
Col. 8-12	Bnode Number	BNODE
Col. 13	Bnode Leg Number	LEGB
Col. 14-19	ADT	ADTD
Col. 20-21	Peak Hour Direction - A Direction	AVDIR
Col. 22-25	Peak-Maximum Hour Beginning - A Direction	AMAXHR
Col. 26	AM or PM Peak Hour - A Direction	AVTIME
Col. 27-30	Peak Hour Volume - A Direction	AVVOL
Col. 31-32	Peak Hour Direction - B Direction	BVDIR
Col. 33-36	Peak-Maximum Hour Beginning - B Direction	BMAXHR
Col. 37	AM or PM Peak Hour - B Direction	BVTIME
Col. 38-41	Peak Hour Volume - B Direction	BVVOL
Col. 42-43	Average Daily Speed	ADASPD
Col. 44-45	AM Peak Speed	AMPKSP
Col. 46	AM Direction	AMDIR
Col. 47-48	PM Peak Speed	PMPKSP
Col. 49	PM Direction	PMDIR
Col. 50-54	A Capacity	ACPACT
Col. 55-59	B Capacity	BCPACT
Col. 60-63	Truck Volume	TRUKVL
Col. 64	Special Topography	SPTOPL

INPUT DATA CARD FORMAT: [illegible] (Continued)

		Variable Name
Col. 65	Capacity Alterations	CPALTL
Col. 66	Sensitive Land Use	SENLUL
Col. 67	CBD - High Rise	CBD
Col. 68	Signal Progression	PROGOL
Col. 69	Functional Class	FCLSSL
Col. 70-72	Distance (x.xx)	LDIST

INPUT CONTROL CARD FORMAT: NETSEN

		Variable Name
Col. 1-6	A.D.T. Low	ADTLW
Col. 7-12	A.D.T. High	ADTHI
Col. 13	C.B.D. Test	CBDTST
Functional Class		
Col. 14	Freeway	FCLASS (1)
Col. 15	Principle Arterial	FCLASS (2)
Col. 16	Minor Arterial	FCLASS (3)
Col. 17	Collector	FCLASS (4)
Col. 18	Local	FCLASS (5)
Special Topography		
Col. 19	Not Present	SPTOPO (1)
Col. 20	Deep Cut	SPTOPO (2)
Col. 21	High Fill	SPTOPO (3)
Col. 22	Street Canyon	SPTOPO (4)
Col. 23	Rolling Topography	SPTOPO (5)
Capacity Alterations		
Col. 24	Not Present	CAPALT (1)
Col. 25	Complex Interchange	CAPALT (2)
Col. 26	Lane Reductions	CAPALT (3)
Col. 27	Bottleneck	CAPALT (4)
Col. 28	Lane Reduction and Bottleneck	CAPALT (5)
Col. 29	Complex Interchange and Bottleneck	CAPALT (6)
Sensitive Land Use		
Col. 30	Not Present	SENLUS (1)
Col. 31	Commercial	SENLUS (2)

INPUT CONTROL CARD FORMAT: [illegible] (Continued)

		Variable Name
Sensitive Land Use (Continued)		
Col. 32	Industrial	SENLUS (3)
Col. 33	Recreational	SENLUS (4)
Col. 34	Hospital	SENLUS (5)
Col. 35	University	SENLUS (6)
Col. 36	Airports	SENLUS (7)
Progressive Movements		
Col. 37	Not Present	PROVOV (1)
Col. 38	Pre-Timed Progressive	PROVOV (2)
Col. 39	Inter-Connected Progressive	PROVOV (3)
Col. 40	One-Way Street Without Progression	PROVOV (4)
Col. 41	One-Way Street With Progression	PROVOV (5)

- -

Col. 42-44	Peak Speed High	PKSPDH
Col. 45-47	Peak Speed Low	PKSPDL
Col. 48-51	Truck High	TRUKHI
Col. 52-55	Truck Low	TRUKLW
Col. 56-58	V/C High (x.xx)	VOCHI
Col. 59-61	V/C Low (x.xx)	VOCLW

CODING: DATA CARD: [illegible]

Variable Name	
ANODE	The A node number is five characters in length, an integer variable and has values ranging from 1 to 99999.
LEGA	The A node leg number is one character in length, an integer variable and has values from 0 to 3. The value of 0 is equal to an intersection leg in a northern direction, 1 is equal to east, 2 is equal to south, and 3 equals west.
BNODE	The B node number is five characters in length, an integer variable and has values ranging from 1 to 99999.
LEGB	The B node leg number has the same values as variable LEGA.
ADTD	The Average Daily Traffic Volume for the link. It is six characters in length, an integer variable and has values ranging from 1 to 999999.
AVDIR	The direction of the peak hour and the type of facility (one-way, two-way, reversible). It is two characters in length, an integer variable and the first digit concerns the type facility, one-way is coded as a 1, two-way is 2, reversible is 3. The second digit refers to direction of this facility, northbound is coded as 1, eastbound equals 3, southbound equals 2, westbound equals 4, and both directions equals 5.

CODING: DATA CARD: [illegible] (Continued)

Variable Name	
AMAXHR	The beginning of the peak hour for the link. It is four characters in length, an integer value, and the first two characters correspond to the hours of the day and the last two correspond to the minutes.
AVTIME	This corresponds to the AM or PM of the day. AM is coded as a 1, PM is coded as a 2, a one digit integer variable. AVTIME is a one digit integer variable.
AVVOL	This variable is the peak hour volume for the link. AVVOL is a four digit integer variable with values from 0 to 9999.

AVDIR, AMAXHR, AVTIME, AVVOL all correspond to BVDIR, BMAXHR, BVTIME, BVVOL.

BVDIR	Two character integer variable. The first digit corresponds to the type of facility, one-way is coded as a 1, two-way is 2, reversible is 3. The second digit refers to direction of the facility, northbound is coded as 1, southbound equals 2, eastbound 3, westbound 4, and both directions equals 5.
BMAXHR	The beginning of the other peak hour for the link. It is a four character integer variable and the first two digits are hours and the last two digits minutes.
BVTIME	This corresponds to the AM or PM time of the peak. AM is coded as a 1, PM is coded as a 2. BVTIME is a one digit integer variable.

CODING: DATA CARD: [redacted] (Continued)

Variable Name	
BVVOL	This is a four digit integer variable corresponding to the peak hour volume for the link under consideration. The range is from 0 to 9999.
ADASPD	Average daily speed for the link. It is an integer variable two digits long and a range from 0 to 99 mph.
AMPKSP	AM peak speed for the link. Integer variable two digits long and a range from 0 to 99.
AMDIR	The direction for the AM peak speed. A northbound direction is coded as a 1, southbound 2, eastbound 3, and westbound 4. A one digit integer variable.
PMPKSP	PM peak speed for the link. Integer variable two digits long and ranges from 0 to 99.
PMDIR	The direction for the PM peak speed. A northbound direction is coded as a 1, southbound 2, eastbound 3, and westbound 4. A one digit integer variable.
ACPACT	The capacity from the A node to the B node. ACPACT is a five digit integer variable with a range from 0 to 99999.
BCPACT	The capacity from the B node to A node. BCPACT is a five digit integer variable with a range from 0 to 99999.
TRUKVL	The truck volume for the link under consideration. TRUKVLis a four digit integer variable with a range from 0 to 9999.

CODING: DATA CARD: NETSEN (Continued)

Variable Name	
SPTOPL	Is a one digit integer variable which represents special topography conditions, values are from 0 to 4 corresponding to: 0 equals not present, 1 equals deep cut, 2 equals high fill, 3 equals street canyon, and 4 equals rolling topography.
CPALTL	Is a one digit integer variable which represents capacity alterations. Values range from 0 to 5 with 0 equaling not present, 1 equals complex interchanges, 2 equals lane reduction, 3 equals bottleneck segment, 4 equals 2 and 3, 5 equals 1 and 3.
SENLUL	Is a one digit integer variable which represents sensitive land uses. Values range from 0 to 6 with 0 equaling not present, 1 equaling commercial development, 2 equaling residential development, 3 equaling recreation, 4 equaling hospitals, 5 universities, and 6 airports. These sensitive land uses are medium to high densities with regard to generation of critical traffic volumes.
CBD	Is a one digit integer variable which represents the Central Business District. Values are 0 for link not in CBD and 1 for link location in CBD.
PROMOL	Is a one digit integer variable which represents progressive movement within the link. Values range from 0 to 4, with 0 equaling not present, 1 pre-timed

CODING: DATA CARD: [redacted] (Continued)

Variable Name	
PROGSL (Continued)	progressive, 2 interconnected progressive signal, 3 one-way street flow without signal progression, 4 one-way street flow with signal progression.
FCLSSL	Is a one digit integer variable which represent the functional classification for the link under consideration. Values range from 0 to 5, with 1 equaling freeway, 2 principle arterial, 3 minor arterial, 4 collector, 5 local.
LDIS	Is a three digit integer variable (programming) representing the distance from A node to B node. The first digit of LDIS is representation of miles and the two digit tenths and hundreds of a mile (x.xx).

CODING: CONTROL CARD: [illegible]

Variable Name

ADTLW	Is a six digit integer variable with a range of 0 to 999999. ADTLW is the average daily traffic flow volume which you want the program to test for.
ADTHI	Is a six digit integer variable with a range of 0 to 999999. ADTHI is the average daily traffic high volume which you want the program to test for.
CBDTST	Is a one digit integer variable with values of 0 to 1. 0 results in the program not testing for the link being located in the Central Business District. 1 results in the link being tested for presence in the CBD.

The following variables, FCLASS, SPTOPO, CAPACT, SEMLUS and PROVOV are all arrays. Each member of the above arrays is set up so that the program tests for the given type variable in the link if a 1 is entered, if a 0 is entered in the column then test is not performed.

(FCLASS (J), J = 1,5)	Is a 1 by 5 array with each variable being a one digit and integer in value.
FCLASS (1)	Test for freeway.
FCLASS (2)	Test for primary arterial.
FCLASS (3)	Test for minor arterial.
FCLASS (4)	Test for collector.
FCLASS (5)	Test for local.
(SPTOPO(J), J = 1,5)	Is a 1 by 5 array with each variable being one digit in length and of integer value.
SPTOPO (1)	Test for not present.
SPTOPO (2)	Test for deep cut.

CODING; CONTROL CARD; NETSEN (Continued)

Variable Name	
SPTOPO (3)	Test for high fill.
SPTOPO (4)	Test for street canyon.
SPTOPO (5)	Test for rolling topography.
(CAPACT(J), J = 1,6)	Is a 1 by 6 array within each variable being one digit in length and of integer value.
CAPACT (1)	Test for not present.
CAPACT (2)	Test for complex interchange.
CAPACT (3)	Test for lane reductions.
CAPACT (4)	Test for bottlenecks.
CAPACT (5)	Test for lane reductions and bottlenecks.
CAPACT (6)	Test for complex interchanges and bottlenecks.
(SENLUS(J), J = 1,7)	Is a 1 by 7 array within each variable being one digit in length and of integer value.
SENLUS (1)	Test for not present.
SENLUS (2)	Test for commercial development.
SENLUS (3)	Test for industrial development.
SENLUS (4)	Test for recreational development.
SENLUS (5)	Test for hospital.
SENLUS (6)	Test for university.
SENLUS (7)	Test for airport development.
(PROVOL(J), J = 1,5)	Is a 1 by 5 array with each variable being one digit in length and of integer value.
PROVOL (1)	Test for not present.
PROVOL (2)	Test for pre-timed progressive.

CODING: CONTROL CARD: [illegible] (Continued)

Variable Name	
PROVOL (3)	Test for interconnected progressive.
PROVOL (4)	Test for one-way street without progression.
PROVOL (5)	Test for one-way street with progression.
PKSPDH	Is a three digit integer variable with a range of 0 to 999. PKSPDH represents the high average daily speed minus the A node to B node and B node to A node peak speed, which the program will test.
PKSPDL	Is a three digit integer variable with a range of 0 to 999. PKSPDL represents the low average daily speed minus the A node to B node and B node to A node peak speed for which the program will test.
TRUKHI	Is a four digit integer variable with a range of 0 to 9999. TRUKHI represents the high volume of trucks that the program will test for on the given links.
TRUKLW	Is a four digit integer variable with a range of 0 to 9999. TRUKLW represents the low volume of trucks that the program will test for on the given links.
VOCHI	Is a decimal variable corresponding to X.XX. VOCHI is the high peak volume over capacity ratio which the program will test for.
VOCLW	Is a decimal variable corresponding to X.XX. VOCLW is the low peak volume over capacity ratio which the program will test for.

```
FORTRAN IV G LEVEL  21                MAIN                DATE = 74303          19/46/04              P.
            C*********************************************************************NETS0010
            C                                                                     NETS0020
            C********** PROGRAM NETSEN **********                                 NETS0030
            C                                                                     NETS0040
            C*********************************************************************NETS0050
            C                                                                     NETS0060
            C   (INPUT: CONTROL CARD=CARD READER, UNIT=05)                        NETS0070
            C   (INPUT: DATA CARD= DISK,UNIT=04)                                  NETS0080
            C                                                                     NETS0090
            C   (OUTPUT: NODE OUTPUT= LINE PRINTER)                               NETS0100
            C   (OUTPUT: NODE OUTPUT= DISK, UNIT=12 INITIALLY)                    NETS0110
            C                                                                     NETS0120
            C                                                                     NETS0130
            C   IBM 360-65                                                        NETS0140
            C   FORTRAN IV  LEVEL G                                               NETS0150
            C   PROGRAM NETSEN VERSION DATE SEPT. 1,1974                          NETS0160
            C                                                                     NETS0170
            C*********************************************************************NETS0180
 0001             INTEGER ANODE,BNODE                                             NETS0190
 0002             INTEGER ADTLW,ADTHI,CBDTST,FCLASS(5),SPTOPO(5),CAPALT(6),SENLUS NETS0200
               B  (7),PROVOV(5),PKSPDH,PKSPDL,TRUKHI,TRUKLW                       NETS0210
 0003             INTEGER ADID,AYDIR,AMAXHR,AYTIME,AYVOL,BYDIR,BMAXHR,BYTIME,BYVOL NETS0220
               B  ,ADASPD,AMPKSP,AMDIR,PMPKSP,PMDIR,ACPACT,BCPACT,TRJKVL,SPTOPL,  NETS0230
               B  CPALTL,SENLUL,CBD,PROMOL,FCLSSL                                 NETS0240
 0004             INTEGER DELJK,DELJRA                                            NETS0250
 0005             INTEGER A,B                                                     NETS0260
            C*********************************************************************NETS0270
            C   INITIALIZE DISK UNIT VALUE.                                       NETS0280
            C*********************************************************************NETS0290
 0006             ISW=11                                                          NETS0300
            C*********************************************************************NETS0310
            C   READ IN CONTROL CARD.                                             NETS0320
            C*********************************************************************NETS0330
 0007       1     READ(  5,2,END=1000)ADTLW,ADTHI,CBDTST,(FCLASS(J),J=1,5),       NETS0340
               B  (SPTOPO(J),J=1,5),(CAPALT(J),J=1,6),(SENLUS(J),J=1,7),          NETS0350
               B  (PROVOV(J),J=1,5), PKSPDH,             PKSPDL,TRUKHI,TRUKLW,    NETS0360
               B  VOCHI,VOCLW                                                     NETS0370
 0008       2     FORMAT(2I6,I1,5I1,5I1,6I1,7I1,5I1,2I3,2I4,2F3.2)                NETS0380
            C*********************************************************************NETS0390
            C   INITIALIZE VARIABLES USED IN PRINTING WHAT IS AND IS NJT TESTED.  NETS0400
            C*********************************************************************NETS0410
 0009             A=1                                                             NETS0420
 0010             B=0                                                             NETS0430
            C*********************************************************************NETS0440
            C   SETTING VALUE OF DISK OUTPUT UNIT.                                NETS0450
            C*********************************************************************NETS0460
 0011             ISW=ISW+1                                                       NETS0470
            C*********************************************************************NETS0480
```

```
              C  WRITING THOSE LINK PARAMETERS TESTED FOR.                                    NETS0490
              C***********************************************************************       NETS0500
   0012             WRITE(6,4)                                                                NETS0510
   0013        4    FORMAT('1',/////2X,'THE FOLLOWING LINK CHARACTERISTIC(S) TESTED ',        NETS0520
                  B 'FOR.'////)                                                               NETS0530
   0014        5    IF(CBDTST.EQ.A) PRINT499                                                  NETS0540
   0015             IF(FCLASS(1).EQ.A) PRINT 500                                              NETS0550
   0016             IF(FCLASS(2).EQ.A)  PRINT 501                                             NETS0560
   0017             IF(FCLASS(3).EQ.A)  PRINT 502                                             NETS0570
   0018             IF(FCLASS(4).EQ.A)  PRINT 503                                             NETS0580
   0019             IF(FCLASS(5).EQ.A)     PRINT 504                                          NETS0590
   0020             IF(A.EQ.1.AND.ADTHI.NE.0) GO TO 6                                         NETS0600
   0021             IF(A.NE.1.AND.ADTHI.EQ.0) GO TO 6                                         NETS0610
   0022             GO TO 7                                                                   NETS0620
   0023        6    PRINT 506 ,ADTLW,ADTHI                                                    NETS0630
   0024        7    IF(SPTOPO(1).EQ.A) PRINT 507                                              NETS0640
   0025             IF(SPTOPO(2).EQ.A)  PRINT 508                                             NETS0650
   0026             IF(SPTOPO(3).EQ.A) PRINT 509                                              NETS0660
   0027             IF(SPTOPO(4).EQ.A) PRINT 510                                              NETS0670
   0028             IF(SPTOPO(5).EQ.A)  PRINT 511                                             NETS0680
   0029             IF(CAPALT(1).EQ.A)  PRINT 512                                             NETS0690
   0030             IF(CAPALT(2).EQ.A)  PRINT 513                                             NETS0700
   0031             IF(CAPALT(3).EQ.A) PRINT 514                                              NETS0710
   0032             IF(CAPALT(4).EQ.A) PRINT 515                                              NETS0720
   0033             IF(CAPALT(5).EQ.A) PRINT 516                                              NETS0730
   0034             IF(CAPALT(6).EQ.A) PRINT 517                                              NETS0740
   0035             IF(SENLUS(1).EQ.A)    PRINT 518                                           NETS0750
   0036             IF(SENLUS(2).EQ.A)    PRINT 519                                           NETS0760
   0037             IF(SENLUS(3).EQ.A)  PRINT 520                                             NETS0770
   0038             IF(SENLUS(4).EQ.A)  PRINT 521                                             NETS0780
   0039             IF(SENLUS(5).EQ.A)  PRINT 522                                             NETS0790
   0040             IF(SENLUS(6).EQ.A)  PRINT 523                                             NETS0800
   0041             IF(SENLUS(7).EQ.A)  PRINT 524                                             NETS0810
   0042             IF(PROVOV(1).EQ.A)  PRINT 525                                             NETS0820
   0043             IF(PROVOV(2).EQ.A)     PRINT 526                                          NETS0830
   0044             IF(PROVOV(3).EQ.A)  PRINT 527                                             NETS0840
   0045             IF(PROVOV(4).EQ.A)  PRINT 528                                             NETS0850
   0046             IF(PROVOV(5).EQ.A) PRINT 529                                              NETS0860
   0047             IF(A.EQ.1.AND.PKSPDH.NE.0) GO TO 9                                        NETS0870
   0048             IF(A.NE.1.AND.PKSPDH.EQ.0) GO TO 9                                        NETS0880
   0049             GO TO 10                                                                  NETS0890
   0050        9    PRINT 531  ,PKSPDL,PKSPDH                                                 NETS0900
   0051       10    IF(A.EQ.1.AND.TRUKHI.NE.0) GO TO 11                                       NETS0910
   0052             IF(A.NE.1.AND.TRUKHI.EQ.0) GO TO 11                                       NETS0920
   0053             GO TO 12                                                                  NETS0930
   0054       11    PRINT 533 ,TRUKLW,TRUKHI                                                  NETS0940
   0055       12    IF(A.EQ.1.AND.VOCHI.NE.0) GO TO 13                                        NETS0950
   0056             IF(A.NE.1.AND.VOCHI.EQ.0) GO TO 13                                        NETS0960
```

```
0057                GO TO 17                                                          NETS0970
0058          13    PRINT 535  ,VOCLW,VOCHI                                           NETS0980
0059          14    FORMAT(///'  THE FOLLOWING LINKS PASSED TESTS '//)                NETS0990
0060          17    IF(A.EQ.1) GO TO 18                                               NETS1000
0061                PRINT 14                                                          NETS1010
0062                GO TO 25                                                          NETS1020
              C***********************************************************************NETS1030
              C  WRITING THOSE LINK PARAMETERS NOT TESTED FOR.                        NETS1040
              C***********************************************************************NETS1050
0063          18    WRITE(6,19)                                                       NETS1060
0064          19    FORMAT('-',////2X,'THE FOLLOWING LINK CHARACTERISTI:(S) NOT TESTEDNETS1070
                   B FOR.'//)                                                         NETS1080
0065                A=0                                                               NETS1090
0066                GO TO 5                                                           NETS1100
              C***********************************************************************NETS1110
              C  READING DATA CARDS OFF OF UNIT 04.                                   NETS1120
              C***********************************************************************NETS1130
0067          25    READ(4,26,END=800)ANODE,LEGA,BNODE,LEGB,ADTD,AVDIR,AMAXHR,AVTIME, NETS1140
                   B AVVOL,BVDIR,BMAXHR,BVTIME,BVVOL,ADASPD,AMPKSP,AMDIR,PMPKSP,       NETS1150
                   B PMDIR,ACPACT,BCPACT,TRUKVL,SPTOPL,CPALTL,SENLUL,CBD,PROMOL,       NETS1160
                   B FCLSSL,LDIS                                                      NETS1170
0068          26    FORMAT(1X,I5,I1,I5,I1,I6,I2,I4,I1,I4,I2,I4,I1,I4,I2,I2,I1,I2,     NETS1180
                   B I1,I5,I5,I4,6I1,I3)                                              NETS1190
              C***********************************************************************NETS1200
              C  INITIALIZE VARIABLES.                                                NETS1210
              C***********************************************************************NETS1220
0069                ICLASS=0                                                          NETS1230
0070                ITOPO=0                                                           NETS1240
0071                ICAPA=0                                                           NETS1250
0072                ISENS=0                                                           NETS1260
0073                IPROG=0                                                           NETS1270
              C***********************************************************************NETS1320
              C  TESTING FOR CBD.                                                     NETS1330
              C***********************************************************************NETS1340
0074                IF(CBDTST.EQ.1.AND.CBD.NE.1)GO TO 25                              NETS1350
0075                GO TO 35                                                          NETS1360
              C***********************************************************************NETS1370
              C  TESTING FOR FUNCTIONAL CLASS.                                        NETS1380
              C***********************************************************************NETS1390
0076          35    DO 36 J=1,5                                                       NETS1400
0077          36    ICLASS=ICLASS+FCLASS(J)                                           NETS1410
0078                IF(ICLASS.EQ.0) GO TO 45                                          NETS1420
0079          37    IF(FCLASS(FCLSSL).EQ.1)GO TO 45                                   NETS1430
0080                GO TO 25                                                          NETS1440
              C***********************************************************************NETS1450
              C  TESTING FOR ADT.                                                     NETS1460
              C***********************************************************************NETS1470
0081          45    IF(ADTHI.EQ.0)GO TO 55                                            NETS1480
```

```
 0082                IF(ADTD.GE.ADTLW.AND.ADTD.LE.ADTHI)GO TO 55                    NETS1490
 0083                GO TO 25                                                        NETS1500
               C***********************************************************************NETS1510
               C  TESTING FOR SPECIAL TOPOGRAPHY.                                    NETS1520
               C***********************************************************************NETS1530
 0084          55    SPTOPL=SPTOPL+1                                                 NETS1540
 0085                DO 56 J=1,5                                                     NETS1550
 0086          56    ITOPO=ITOPO+SPTOPO(J)                                           NETS1560
 0087                IF(ITOPO.EQ.0) GO TO 65                                         NETS1570
 0088                IF(SPTOPO(SPTOPL).EQ.1)GO TO 65                                 NETS1580
 0089                GO TO 25                                                        NETS1590
               C***********************************************************************NETS1600
               C  TESTING FOR CAPACITY ALTERATIONS.                                  NETS1610
               C***********************************************************************NETS1620
 0090          65    CPALTL=CPALTL+1                                                 NETS1630
 0091                DO 66 J=1,6                                                     NETS1640
 0092          66    ICAPA=ICAPA+CAPALT(J)                                           NETS1650
 0093                IF(ICAPA.EQ.0) GO TO 75                                         NETS1660
 0094                IF(CAPALT(CPALTL).EQ.1)GO TO 75                                 NETS1670
 0095                GO TO 25                                                        NETS1680
               C***********************************************************************NETS1690
               C  TESTING FOR SENSITIVE LAND USE.                                    NETS1700
               C***********************************************************************NETS1710
 0096          75    SENLUL=SENLUL+1                                                 NETS1720
 0097                DO 76 J=1,7                                                     NETS1730
 0098          76    ISENS=ISENS+SENLUS(J)                                           NETS1740
 0099                IF(ISENS.EQ.0) GO TO 85                                         NETS1750
 0100                IF(SENLUS(SENLUL).EQ.1) GO TO 85                                NETS1760
 0101                GO TO 25                                                        NETS1770
               C***********************************************************************NETS1780
               C  TESTING FOR PROGRESSIVE MOVEMENT.                                  NETS1790
               C***********************************************************************NETS1800
 0102          85    PROMOL=PROMOL+1                                                 NETS1810
 0103                DO 86 J=1,5                                                     NETS1820
 0104          86    IPROG=IPROG+PROVOV(J)                                           NETS1830
 0105                IF(IPROG.EQ.0) GO TO 95                                         NETS1840
 0106                IF(PROVOV(PROMOL).EQ.1)GO TO 95                                 NETS1850
 0107                GO TO 25                                                        NETS1860
               C***********************************************************************NETS1870
               C  TESTING FOR SPEED DIFFERENCE OF AVERAGE DAILY SPEED MINUS          NETS1880
               C     PEAK SPEED.                                                     NETS1890
               C***********************************************************************NETS1900
 0108          95    DELJR=ADASPD-AMPKSP                                             NETS1910
 0109                IF(PKSPDH.EQ.0) GO TO 105                                       NETS1920
 0110                IF(DELJR.LE.PKSPDH.AND.DELJR.GE.PKSPDL) GO TO 100               NETS1930
 0111                GO TO 25                                                        NETS1940
 0112          100   DELJRA=ADASPD-PMPKSP                                            NETS1950
 0113                IF(DELJRA.LE.PKSPDH.AND.DELJRA.GE.PKSPDL) GO TO 105             NETS1960
 0114                 GO TO25                                                             NETS1970
               C**********************************************************************NETS1980
               C  TESTING FOR TRUCK VOLUMES.                                          NETS1990
               C**********************************************************************NETS2000
 0115          105    IF(TRUKHI.EQ.0) GO TO 115                                       NETS2010
 0116                 IF(TRUKVL.LE.TRUKHI.AND.TRUKVL.GE.TRUKLW)GO TO 115              NETS2020
 0117                 GO TO 25                                                        NETS2030
               C**********************************************************************NETS2040
               C  TESTING FOR V OVER C.                                               NETS2050
               C**********************************************************************NETS2060
 0118          115    IF(VOCHI.EQ.0) GO TO 130                                        NETS2070
 0119                 IF(ACPACT.EQ.0.AND.AVVOL.EQ.0) GO TO 25                         NETS2080
 0120                 IF(ACPACT.EQ.0) GO TO 119                                       NETS2090
 0121                 IF(AVDIR.EQ.25) GO TO 116                                       NETS2100
 0122                 IF(AVVOL.EQ.0)AVVOL= .1*ADTD/2                                  NETS2110
 0123                 SAVEA=FLOAT(AVVOL)/FLOAT(ACPACT)                                NETS2120
 0124                 IF(SAVEA.LE.VOCHI.AND.SAVEA.GE.VOCLW)GO TO 120                  NETS2130
 0125                 GO TO 25                                                        NETS2140
 0126          116    SAVEA=FLOAT(AVVOL)/FLOAT(ACPACT)                                NETS2150
 0127                 IF(SAVEA.LE.VOCHI.AND.SAVEA.GE.VOCLW) GO TO 130                 NETS2160
 0128                 GO TO 25                                                        NETS2170
 0129          117    FORMAT(' ',5X,I5,5X,I5,'***ERROR***',' DIVISION BY ZERO',       NETS2180
                    * ' ATTEMPTED')                                                   NETS2190
 0130          119    PRINT 117, ANODE,BNODE                                          NETS2200
 0131                 GOTO25                                                          NETS2210
 0132          120    IF(BCPACT.EQ.0.AND.BVVOL.EQ.0) GO TO 25                         NETS2220
 0133                 IF(BCPACT.EQ.0) GO TO 119                                       NETS2230
 0134                 IF(BVVOL.EQ.0)BVVOL= .1*ADTD/2                                  NETS2240
 0135                 SAVEB=FLOAT(BVVOL)/FLOAT(BCPACT)                                NETS2250
 0136                 IF(SAVEB.LE.VOCHI.AND.SAVEB.GE.VOCLW)GO TO 130                  NETS2260
 0137                 GO TO 25                                                        NETS2270
               C**********************************************************************NETS2280
               C  WRITING OF LINKS THAT PASSED ON TO LINE-PRINTER.                    NETS2290
               C**********************************************************************NETS2300
 0138          130    WRITE(6,131)ANODE,LEGA,BNODE,LEGB                               NETS2310
 0139          131    FORMAT(10X,I5,2X,I1,10X,I5,2X,I1)                               NETS2320
               C**********************************************************************NETS2330
               C  WRITING OF LINKS THAT PASSED ON TO DISK.                            NETS2340
               C**********************************************************************NETS2350
 0140                 WRITE(ISW,135) ANODE,LEGA,BNODE,LEGB                            NETS2360
 0141          135    FORMAT(1X,I5,I1,I5,I1)                                          NETS2370
 0142                 GO TO 25                                                        NETS2380
               C**********************************************************************NETS2390
               C  FORMATING FOR PARAMETERS TO BE AND NOT TO BE TESTED FOR.            NETS2400
               C**********************************************************************NETS2410
 0143          499    FORMAT('      CBDTST: CENTRAL BUSINESS DIST.')                  NETS2420
 0144          500    FORMAT('      FCLASS(1): FREEWAY ')                             NETS2430
 0145          501    FORMAT('      FCLASS(2): PRINCIPLE ARTERIAL ')                  NETS2440
```

```
0146        502   FORMAT('     FCLASS(3): MINOR ARTERIAL ')                    NETS2450
0147        503   FORMAT('     FCLASS(4): COLLECTOR')                          NETS2460
0148        504   FORMAT('     FCLASS(5): LOCAL')                              NETS2470
0149        506   FORMAT('     ADTHI: AVE. DAILY TRAFFIC',5X,I7,'  TO  ',I7)   NETS2480
0150        507   FORMAT('     SPTOPO(1): NOT PRESENT ')                       NETS2490
0151        508   FORMAT('     SPTOPO(2): DEEP CUT')                           NETS2500
0152        509   FORMAT('     SPTOPO(3): HIGH FILL ')                         NETS2510
0153        510   FORMAT('     SPTOPO(4): STREET CANYON')                      NETS2520
0154        511   FORMAT('     SPTOPO(5): ROLLING TOPO.')                      NETS2530
0155        512   FORMAT('     CAPALT(1): NOT PRESENT')                        NETS2540
0156        513   FORMAT('     CAPALT(2): COMPLEX INTERCHANGE')                NETS2550
0157        514   FORMAT('     CAPALT(3): LANE REDUCTION')                     NETS2560
0158        515   FORMAT('     CAPALT(4): BOTTLENECK ')                        NETS2570
0159        516   FORMAT('     CAPALT(5): LANE REDUCTION AND BOTTLENECK')      NETS2580
0160        517   FORMAT('     CAPALT(6): COMPLEX INTER. AND BOTTLENECK')      NETS2590
0161        518   FORMAT('     SENLUL(1): NOT PRESENT ')                       NETS2600
0162        519   FORMAT('     SENLUL(2): COMMERCIAL')                         NETS2610
0163        520   FORMAT('     SENLUL(3): INDUSTRIAL')                         NETS2620
0164        521   FORMAT('     SENLUL(4): RECREATIONAL')                       NETS2630
0165        522   FORMAT('     SENLUL(5): HOSPITAL')                           NETS2640
0166        523   FORMAT('     SENLUL(6): UNIVERSITY')                         NETS2650
0167        524   FORMAT('     SENLUL(7): AIRPORTS')                           NETS2660
0168        525     FORMAT('     PROVOV(1) NOT PRESENT')                       NETS2670
0169        526   FORMAT('     PROVOV(2): PRE-TIMED PROG.')                    NETS2680
0170        527   FORMAT('     PROVOV(3): INTER-CONN. PROG.')                  NETS2690
0171        528   FORMAT('     PROVOV(4): ONE WAY STREET WITHOUT PROG.')       NETS2700
0172        529   FORMAT('     PROVOV(5): ONE WAY STREET WITH PROG.' )         NETS2710
0173        531   FORMAT('     PKSPDH: PEAK SPEED',5X,I6,'  TO  ',I6)          NETS2720
0174        533   FORMAT('     TRUCK VOLUME.',5X,I6,'  TO  ',I6)               NETS2730
0175        535   FORMAT('     V OVER C, PEAK',5X,I6,'  TO  ',I6)              NETS2740
                  C*********************************************************************NETS2750
                  C   RETURN TO BEGINNING OF DATA CARD FILE.                  NETS2760
                  C   THIS WILL OCCUR WHEN MULTIPLE CONTROL CARDS ARE READ.   NETS2770
                  C*********************************************************************NETS2780
0176              800   REWIND4                                               NETS2790
0177                    GO TO 1                                               NETS2800
                  C*********************************************************************NETS2810
                  C   END OF PROGRAM.                                         NETS2820
                  C*********************************************************************NETS2830
0178              1000  END FILE 12                                           NETS2840
0179                    STOP                                                  NETS2850
0180                    END                                                   NETS2860
```

OUTPUT: [illegible]: LINE PRINTER

	Variable Name	
Col. 1-10	Blank	
Col. 11-15	ANODE	ANODE NUMBER
Col. 16-17	Blank	
Col. 18	LEGA	ANODE LEG NUMBER
Col. 19-28	Blank	
Col. 29-34	BNODE	BNODE NUMBER
Col. 35-36	Blank	
Col. 37	LEGB	BNODE LEG NUMBER

OUTPUT: [illegible]: DISK UNIT

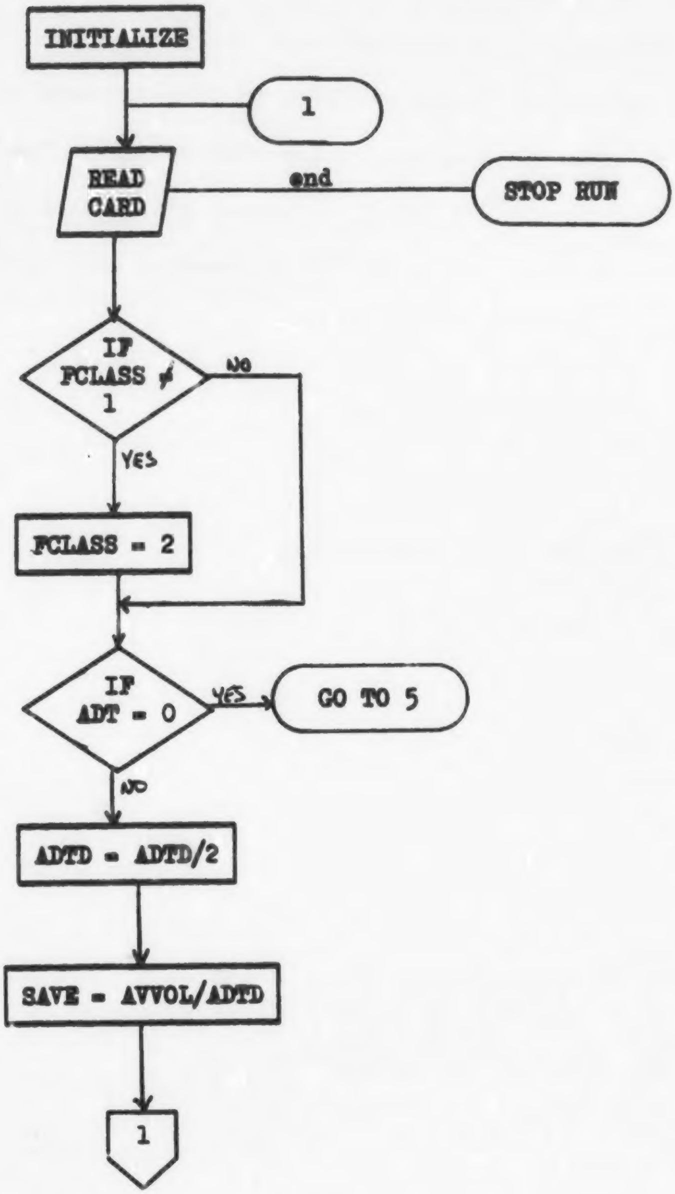
Col. 1	Blank	
Col. 2-6	ANODE	ANODE NUMBER
Col. 7	LEGA	ANODE LEG NUMBER
Col. 8-12	BNODE	BNODE NUMBEP
Col. 13	LEGB	BNODE LEG NUMBER

```
THE FOLLOWING LINK CHARACTERISTIC(S) TESTED FOR.

    FCLASS(1): FREEWAY
    ADTHI: AVE. DAILY TRAFFIC        50000  TO     59999


THE FOLLOWING LINK CHARACTERISTIC(S) NOT TESTED FOR.

    CBDTST: CENTRAL BUSINESS DIST.
    FCLASS(2): PRINCIPLE ARTERIAL
    FCLASS(3): MINOR ARTERIAL
    FCLASS(4): COLLECTOR
    FCLASS(5): LOCAL
    SPTOPO(1): NOT PRESENT
    SPTOPO(2): DEEP CUT
    SPTOPO(3): HIGH FILL
    SPTOPO(4): STREET CANYON
    SPTOPO(5): ROLLING TOPO.
    CAPALT(1): NOT PRESENT
    CAPALT(2): COMPLEX INTERCHANGE
    CAPALT(3): LANE REDUCTION
    CAPALT(4): BOTTLENECK
    CAPALT(5): LANE REDUCTION AND BOTTLENECK
    CAPALT(6): COMPLEX INTER. AND BOTTLENECK
    SENLUL(1): NOT PRESENT
    SENLUL(2): COMMERCIAL
    SENLUL(3): INDUSTRIAL
    SENLUL(4): RECREATIONAL
    SENLUL(5): HOSPITAL
    SENLUL(6): UNIVERSITY
    SENLUL(7): AIRPORTS
    PROVOV(1) NOT PRESENT
    PROVOV(2): PRE-TIMED PROG.
    PROVOV(3): INTER-CONN. PROG.
    PROVOV(4): ONE WAY STREET WITHOUT PROG.
    PROVOV(5): ONE WAY STREET WITH PROG.
    PKSPDM: PEAK SPEED              0  TO       0
    TRUCK VOLUME.               0  TO       0
    V OVER C, PEAK               0  TO       0


THE FOLLOWING LINKS PASSED TESTS

             165              168
             168              171
             174              177
             190              193
             193              186
             196              189
             192              195
             195              198
            1004             1005
```

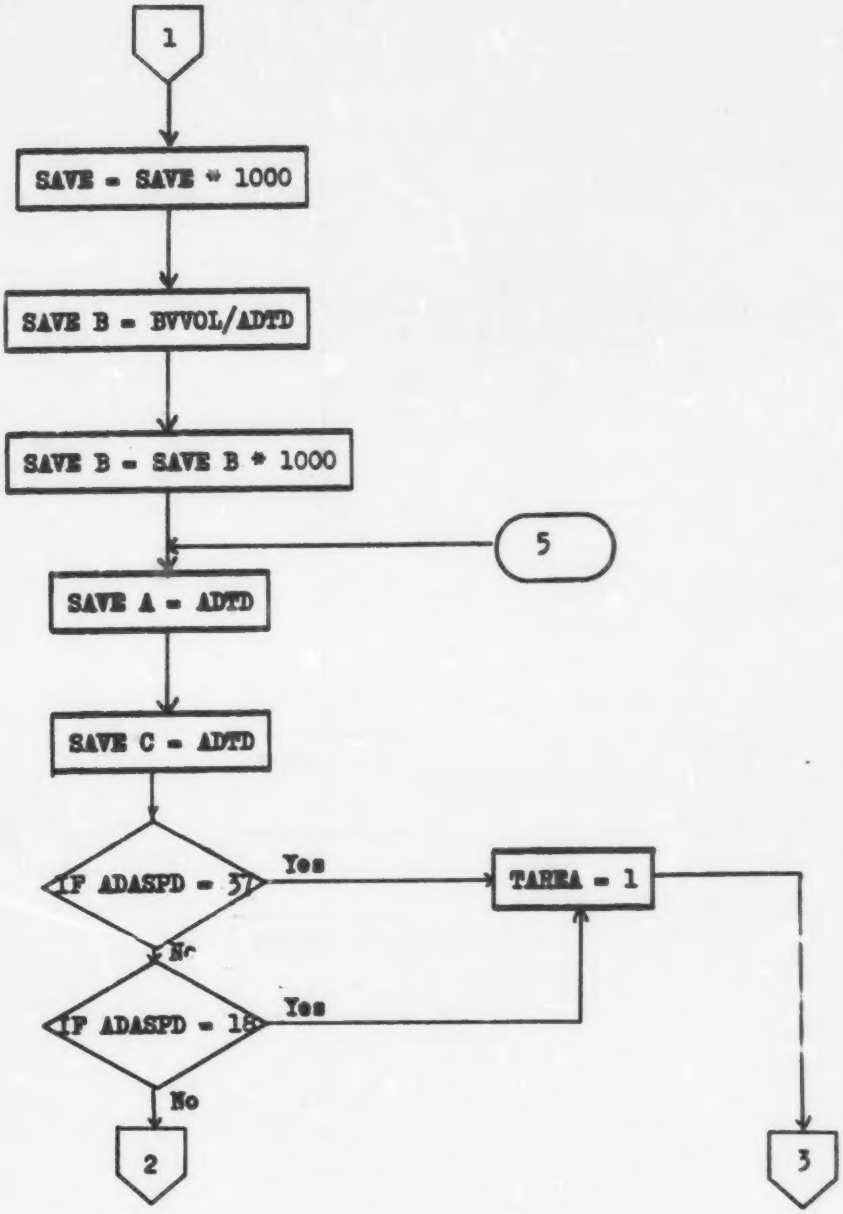
A-2 HRCVRT PROGRAM

HRCVRT is an initialising program which accepts as input the highway link record file. This is the same input as is used for NETSEN. HRCVRT then takes each record and puts it into a format which will be acceptable to the programs in the FHWA battery. The output of HRCVRT is then printed on the line printer and on disk or tape. The following pages contains the HRCVRT programming logic and statements.

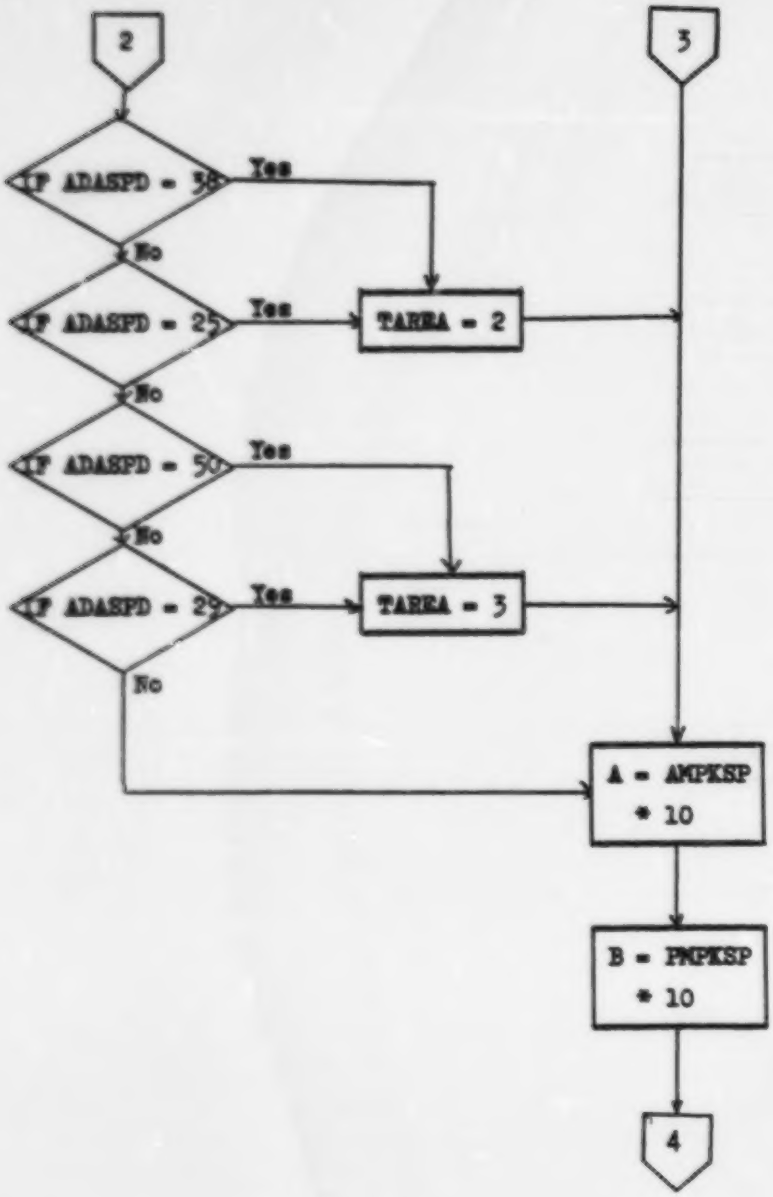
RECVRT


INITIALIZE
1
READ CARD
end
STOP RUN
IF FCLASS ≠ 1
NO
YES
FCLASS = 2
IF ADT = 0
YES
GO TO 5
NO
ADTD = ADTD/2
SAVE = AVVOL/ADTD
1

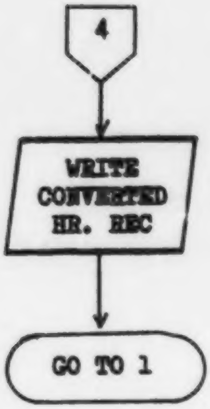
HRCVRT


1
SAVE = SAVE * 1000
SAVE B = BVVOL/ADTD
SAVE B = SAVE B * 1000
5
SAVE A = ADTD
SAVE C = ADTD
IF ADASPD = 37
Yes
TAREA = 1
No
IF ADASPD = 18
Yes
No
2
3

SECRET


2
3
IF ADASPD = 38
Yes
No
IF ADASPD = 25
Yes
TAREA = 2
No
IF ADASPD = 50
Yes
No
IF ADASPD = 29
Yes
TAREA = 3
No
A = AMPKSP * 10
B = PMPKSP * 10
4

HRCVRT


4
WRITE CONVERTED HR. REC
GO TO 1

INPUT: HRCVRT: DATA CARD

The input to Historical Record Convert (HRCVRT) is exactly the same as the input to NETSEN shown on pages 102 and 103.

OUTPUT: HRCVRT

The output of HRCVRT is on a line printer and on disk, tape or cards, whichever the user specifies in his JCL (Job Control Language). The format of the output on the line printer and the disk, tape or cards is identical as follows:

Col. 1	Blank	
Col. 2-6	ANODE	A node number.
Col. 7	LEGA	A node leg number.
Col. 8-12	BNODE	B node number.
Col. 13	LEGB	B node leg number.
Col. 14-17	LDIST	Distance from A node to B node.
Col. 18	SPEED	Speed parameters to be used in SAPOLLUT.
Col. 19-21	A	AM peak speed in SAPOLLUT usable form.
Col. 22-24	Blank	
Col. 25-28	ACPACT	Capacity from A node to B node.
Col. 29-31	SAVE	Equal to the peak hour V over C ratio.
Col. 32-36	SAVEA	Equal to the Average Daily Traffic, both directions.
Col. 37-38	Blank	
Col. 39	Blank	
Col. 40	Blank	
Col. 41	SPEEDA	Speed parameter to be used in SAPOLLUT.

OUTPUT: BRCVRT (Continued)

Col. 42-44	B	PM peak speed in SAPOLLUT usable form.
Col. 45-47	Blank	
Col. 48-51	BCPACT	Capacity from B node to A node.
Col. 52-54	SAVEB	Equal to the Average Daily Traffic for both directions in SAPOLLUT usable form.
Col. 55-59	SAVEC	Equal to the Average Daily Traffic volume for both directions.
Col. 60-61	Blank	
Col. 62	Blank	
Col. 63	Blank	
Col. 64	Blank	
Col. 65	FCLSSL	Functional Classification.
Col. 66	Blank	
Col. 67	Blank	
Col. 68	TAREA	The area type which the link is in.
Col. 69-70	Blank	
Col. 71-74	Blank	
Col. 75-78	Blank	
Col. 79	Blank	
Col. 80	Blank	

CODING: HRCVRT: DATA CARD

See the explanation on CODING: DATA CARD: NETSEN as it records input into NETSEN which HRCVRT converts into BUILDER acceptable format. The following pages illustrate the HRCVRT coding, program statements, and output.

HRCVET Program Statements

```
FORTRAN IV G LEVEL  21                    MAIN                    DATE = 74303            13/40/53          P

 0001                 INTEGER ANODE,BNODE,ADTD,AVDIR,AMAXHR,AVTIME,AVVOL,BVDIR,
                    B BMAXHR,BVTIME,BVVOL,ADASPD,AMPKSP,AMDIR,PMPKSP,PMDIR,ACPACT,
                    B BCPACT,TRUKVL ,SPTOPL,CPALTL,SENLUL,CBD,PROMOL,FCLSSL,SAVE,
                    B SAVEA,SAVEB,SAVEC,TAREA
 0002                 INTEGER A,B
 0003                 DATA SPEED/'S'/,SPEEDA/'S'/
 0004          1      READ(4,2,END=100) ANODE,LEGA,BNODE,LEGB,ADTD,AVDIR,AMAXHR,
                    B AVTIME,AVVOL,
                    B BVDIR,BMAXHR,BVTIME,BVVOL,ADASPD,AMPKSP,AMDIR,PMPKSP,PMDIR,
                    B ACPACT,BCPACT,
                    B TRUKVL,SPTOPL,CPALTL,SENLUL,CBD,PROMOL,FCLSSL,LDIST
 0005          2      FORMAT(1X,I5,I1,I5,I1,I6,I2,I4,I1,I4,I2,I4,I1,I4,I2,I2,I1,
                    B I2,I1,I5,I5,I4,6I1,I3)
 0006                 IF(FCLSSL.NE.1) FCLSSL=2
 0007                 IF(ADTD.EQ.0) GO TO 5
 0008                 ADTD=ADTD/2
 0009                 SAVE=AVVOL/ADTD
 0010                 SAVE=SAVE*1000
 0011                 SAVEB=BVVOL/ADTD
 0012                 SAVEB=SAVEB*1000
 0013          5      SAVEA=ADTD
 0014                 SAVEC=ADTD
 0015                 IF(ADASPD.EQ.37) GO TO 25
 0016                 IF(ADASPD.EQ.18) GO TO25
 0017                 IF(ADASPD.EQ.39) GO TO 28
 0018                 IF(ADASPD.EQ.25) GO TO 28
 0019                 IF(ADASPD.EQ.50) GO TO 30
 0020                 IF(ADASPD.EQ.29) GO TO 30
 0021                 GO TO 50
 0022         25      TAREA=1
 0023                 GO TO 50
 0024         28      TAREA=2
 0025                 GO TO 50
 0026         30      TAREA=3
 0027                 GO TO 50
 0028         50      CONTINUE
 0029                 A=AMPKSP*10
 0030                 B=PMPKSP*10
 0031         14      WRITE(6,15)ANODE,LEGA,BNODE,LEGB,LDIST,SPEED,A,ACPACT,SAVE,SAVEA,
                    B SPEEDA,B,BCPACT,SAVEB,SAVEC,FCLSSL,TAREA
 0032                 WRITE(12,15) ANODE,LEGA,BNODE,LEGB,LDIST,SPEED,A,ACPACT,SAVE,
                    B SAVEA,
                    B SPEEDA,B,BCPACT,SAVEB,SAVEC,FCLSSL,TAREA
 0033         15      FORMAT(1X,I5,I1,I5,I1,I4,A1,I3   ,3X,I4,I3,I5,2X,1X,1X,
                    B A1,I3   ,3X,I4,I3,I5,2X,1X,1X,1X,I1,1X,1X,I1,2X,4X,4X,1X,1X)
 0034                 GO TO 1
 0035        100      END FILE 12
 0036                 STOP
```

HRCVRT OUTPUT

```
 1651   1683  100S550    8000  028972    S520   8000  028972    1  3
 1681   1713  220S550    8000  029152    S550   8000  029152    1  3
 1711   1743   40S550    8000  021975    S550   8000  021975    1  3
 1741   1773   36S550    8000  029215    S550   8000  029215    1  3
 1771   1803  240S530    8000  0      0  S530   8000  0      0  1  2
 1801   1833  120S530    8000  026663    S530   8000  026663    1  2
 1831   1863   40S530    8000  029347    S530   8000  029347    1  2
 1861   1893  140S550    8000  028313    S500   8000  028313    1  2
 1891   1923   50S550    8000  021398    S550   8000  021398    1  2
 1921   1953  130S550    8000  025602    S550   8000  025602    1  2
 1951   1983  120S550    8000  026157    S490   8000  026157    1  2
 1981   2013   50S170    8000  022373    S410   8000  022373    1  2
10011  10023  120S  0    4000  0      0  S  0   4000  0      0  1  3
10021  10033  355S  0    4000  0      0  S  0   4000  0      0  1  3
10031  10043  296S  0    4000  022500    S  0   4000  022500    1  3
10041  10053  116S  0    4000  028185    S  0   4000  028185    1  3
10051  13293  150S  0    1200  011985    S  0   1200  011985    2  2
10051100513   150S210    4000  032945    S200   4000  032945    1  2
10061  10073  157S200    4000  028005    S160   4000  028005    1  3
10070  13622   96S250    1200  012350    S330   1200  012350    2  3
10071  10083   93S  0    4000  028065    S  0   4000  028065    1  3
10080  14292   75S  0    1800  023958    S  0   1800  023958    2  3
10081  10093   68S  0    4000  036550    S  0   4000  036550    1  3
10082  13630   47S  0    1800  025241    S  0   1800  025241    2  3
10090  14291  100S  0     600  0 6993    S  0    600  0 6993    2  3
10091  10103   98S  0    4000  036550    S  0   4000  036550    1  3
10101  10113   80S  0    6000  038845    S  0   6000  038845    2  3
10111  10123   35S  0    6000  038845    S  0   6000  038845    1  3
10120  14312  110S  0     600  0 8183    S  0    600  0 8183    2  3
10121  10133  200S  0    6000  038845    S  0   6000  038845    1  3
10122  13920   34S  0     600  012445    S  0    600  012445    2  3
10130  14352  250S  0     600  0 6625    S  0    600  0 6625    2  3
10131  10143   62S  0    6000  038845    S  0   6000  038845    1  3
10132  19290   70S  0     600  0 5803    S  0    600  0 5803    2  3
10140  14372  200S200    1200  015688    S150   1200  015688    2  3
10141  10153   74S270    6000  046280    S270   6000  046280    1  3
10150  14382  245S230       0  0 4548    S160      0  0 4548    2  3
10151  10163   65S470    6000  048025    S370   6000  048025    1  3
10160  14512  120S150    1800  016812    S240   1800  016812    2  3
10161  10173  110S450    6000  048845    S370   6000  048845    1  3
10162  13950   70S  0    1200  012495    S  0   1200  012495    2  3
10171  10183   33S240    6000  049025    S210   6000  049025    1  3
10180  12602   85S250    1200  0 6506    S250   1200  0 6506    2  2
10181  10193   29S320    6000  046730    S220   6000  046730    1  2
10182  12640   90S  0    1200  011602    S  0   1200  011602    2  2
10190  12012   75S  0    1200  0 6506    S  0   1200  0 6506    2  2
10191  10203   90S370    6000  046070    S250   6000  046070    1  2
10200  17602   70S  0    1200  0 5004    S  0   1200  0 5004    2  2
10201  10213   34S430    9999  046070    S430   9999  046070    1  2
10202  12660   80S  0    1200  011365    S  0   1200  011365    2  2
10210  17762   20S  0    1200  0 7696    S  0   1200  0 7696    2  2
10211  10223   45S360    9999  048480    S400   9999  048480    1  2
10212  12680   60S210    1800  013140    S190   1800  013140    2  2
10221  10233   63S430    9999  048480    S500   9999  048480    1  2
10230  17632   60S400    1200  0 8927    S270   1200  0 8927    2  2
10231  10243   47S  0    9999  046130    S520   9999  046130    1  2
10240  12292   30S  0     600  0 2847    S  0    600  0 2847    2  2
```

A-3 DATA MANAGEMENT PROGRAM
Deck Name: GIN

A.) Purpose:

GIN reads in reformatted inventory data, then adds keys and outputs an indexed sequential data set of the reformatted network data, which becomes the link record format for BUILDHR.

B.) Input-Output:

Data sets used during the execution of the program include:

1. SYSPRINT - the standard "system print" file for program and system messages.
2. CNVRT - the input data set from the Format Revision Program HRCVRT. This format is depicted on pages 102 and 103.
3. CNVRTK - the indexed sequential output data set of BUILDHR compatible link records. Note: indexed sequential data sets are only supported on direct-access devices (disk) and not tape.

C.) Program Operation:

1. Program reads in one link record from CNVRT.
2. Program extracts the first 13 characters of the record and then writes the record onto an indexed sequential data set (CNVRTK) using the first 13 characters as a key.
3. Program proceeds through all records in CNVRT in similar manner. Note: link records must be presented to the program in ascending numeric order of the first 13 characters on the original link data card. If a card is out of order it is ignored. When 10 such cards are encountered a message is issued and the program is terminated.

D.) Additional Information

1. The program was written initially in IBM S/360 PL1 Version 5.4.
2. The input format is the link record format used for input to BUILDHR, the FHWA Battery Program.
3. The output format is the same as the input in appearance with keys attached internally.
4. Execution of the load module form of the program should require approximately 35K of main core storage.

E.) Source Program Listing and Flow Chart

The source program listing is included on the following page, followed by the program flow chart in Figure A-1.

```
       GIN : PROC OPTIONS(MAIN);

STMT LEVEL NEST
  1                 GIN : PROC OPTIONS(MAIN);
  2     1            DCL 1 OVRAL,
                       2 NODES CHAR(13),
                       2 REST CHAR(67),
                    CNVRT INPUT RECORD SEQUENTIAL,
                     CNVRTK RECORD FILE SEQUENTIAL OUTPUT BUFFERED KEYED ENVIRONMENT(INDEXED);
  3     1            ON KEY (CNVRTK) GO TO ERMES;
  5     1            ON ENDFILE (CNVRT) GO TO ENDAL;
  7     1            N=0;
  8     1             OPEN FILE(CNVRT), FILE(CNVRTK);
  9     1            STRT: READ FILE (CNVRT) INTO (OVRAL);
 10     1            PUT SKIP EDIT (OVRAL.NODES,OVRAL.REST) (A(13),A(67));
 11     1            WRITE FILE (CNVRTK) FROM (OVRAL) KEYFROM(OVRAL.NODES);
 12     1            GO TO STRT;
 13     1            ERMES: PUT SKIP(1) LIST ('THE ABOVE LINK RAISED KEY CONDITION');
 14     1            N=N+1;
 15     1            IF N> 10 THEN DO;
 17     1     1      PUT SKIP(1) LIST ('KEY CONDITION RAISED',N,'TIMES, EXECUTION TERMINATED');
 18     1     1      GO TO ENDAL;
 19     1     1      END;
 20     1            GO TO STRT;
 21     1           ENDAL: CLOSE FILE (CNVRTK), FILE(CNVRT);
 22     1           END GIN;
```

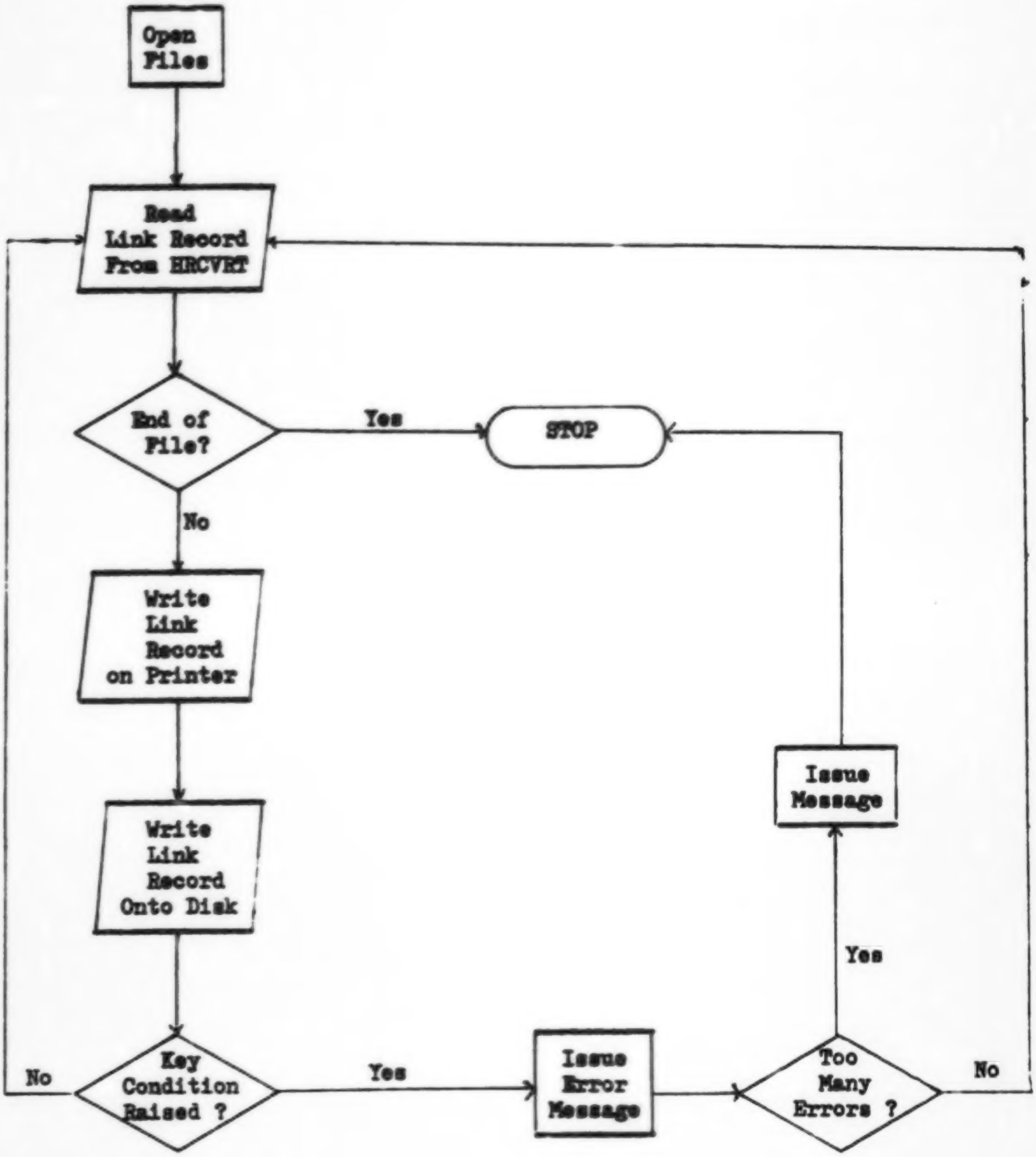

Open Files
Read Link Record From HRCVRT
End of File?
Yes
STOP
No
Write Link Record on Printer
Write Link Record Onto Disk
Key Condition Raised ?
No
Yes
Issue Error Message
Too Many Errors ?
No
Yes
Issue Message

FIGURE A-1 Program GIN Flowchart

A-4 INTERFACE PROGRAM

Deck Name: RUMMY

A.) Purpose:

RUMMY reads in a node pair from the NETSEN output data set and uses it to select the appropriate link record from the output indexed sequential data set of program GIN. It then performs editing and builds a workable network which is passed to BUILDHR.

B.) Input-Output:

Data sets used during the execution of the program include:

1. SYSPRINT - standard systems output message data set.
2. CNVRTK - input data set (indexed sequential) from which link records are selected with appropriate keys. Format is depicted on pages 102 and 103.
3. NODEP - input data set from NETSEN from which A-node-B-node pair are read to be used as keys to select link records from CNVRTK.
4. CNVRTO - output data set of link records which are passed to BUILDHR. The format is the same on pages 102 and 103.

C.) Additional Notes

1. The program is written in IBM S/360 PL1 Version 5.4 and occupies approximately 48K of main core.
2. Link records presented to the program should be organized with the A-node larger than the B-node.

D.) Program Source Listing and Flow Chart

The program source listing is included, in the following pages, along with the program flow chart in Figure A-2.

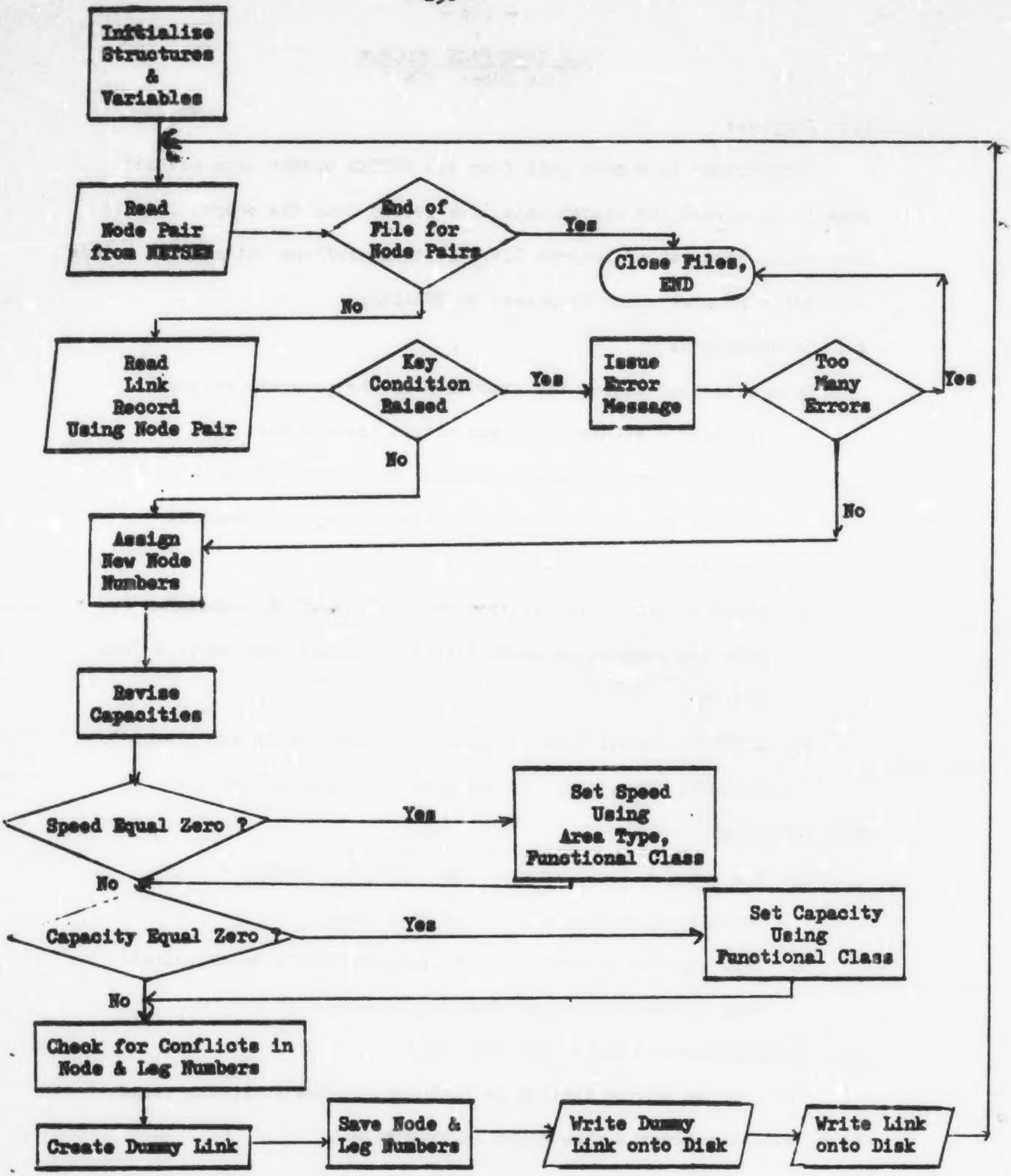

Initialize Structures & Variables
Read Node Pair from NETSEM
End of File for Node Pairs
Yes
Close Files, END
No
Read Link Record Using Node Pair
Key Condition Raised
Yes
Issue Error Message
Too Many Errors
Yes
No
No
Assign New Node Numbers
Revise Capacities
Speed Equal Zero ?
Yes
Set Speed Using Area Type, Functional Class
No
Capacity Equal Zero ?
Yes
Set Capacity Using Functional Class
No
Check for Conflicts in Node & Leg Numbers
Create Dummy Link
Save Node & Leg Numbers
Write Dummy Link onto Disk
Write Link onto Disk

FIGURE A-2 Program DUMMY Flowchart

```
        RUMMY: PROC OPTIONS(MAIN);

  STMT LEVEL NEST
    1                     RUMMY: PROC OPTIONS(MAIN);
    2     1                DCL NODEP  RECORD SEQUENTIAL INPUT,
                             CNVRTK DIRECT INPUT KEYED ENVIRONMENT(INDEXED),
                            CNVRTO SEQUENTIAL RECORD OUTPUT ENVIRONMENT(F(1600,80)),
                             NDPI   CHAR(13),
                           1 CNVKIN,
                              2 GAPO PIC 'X',
                             2  ANODE PIC '99999',
                             2  ALEG PIC '9',
                             2  BNODE PIC '99999',
                             2  BLEG PIC '9',
                             2 DIST PIC '9999',
                              2 TS1 PIC 'X',
                              2   SPEEDA  PIC '999',
                              2 TPEN1 PIC '999',
                             2 ABCAP PIC '9999',
                              2 CONVFA PIC '999',
                             2 AVOL PIC '(5)9',
                              2 MISC1 PIC '9999',
                              2 TS2 PIC 'X',
                              2 SPEEDB  PIC '999',
                              2 TPEN2 PIC '999',
                             2 BACAP PIC '9999',
                              2 CONVFB PIC '999',
                             2 BVOL PIC '(5)9',
                              2 MISC3 PIC '(5)9',
                             2 FCLASS PIC '9',
                              2 MISC4 PIC '99',
                             2 ATYPE PIC '9',
                              2 REST PIC '(12)9',
                           1 DUMREC,
                              2 GAPO PIC 'X',
                             2  ANODE PIC '99999',
                             2  ALEG PIC '9',
                             2  BNODE PIC '99999',
                             2  BLEG PIC '9',
                             2 DIST PIC '9999',
                              2 TS1 PIC 'X',
                              2   SPEEDA  PIC '999',
                              2 TPEN1 PIC '999',
                             2 ABCAP PIC '9999',
                              2 CONVFA PIC '999',
                             2 AVOL PIC '(5)9',
                              2 MISC1 PIC '9999',
                              2 TS2 PIC 'X',
                              2 SPEEDB  PIC '999',
                              2 TPEN2 PIC '999',
                             2 BACAP PIC '9999',
                              2 CONVFB PIC '999',
                             2 BVOL PIC '(5)9',
                              2 MISC3 PIC '(5)9',
            RUMMY: PROC OPTIONS(MAIN);

 STMT LEVEL NEST
                         2 FCLASS PIC '9',
                          2 MISC4 PIC '99',
                         2 ATYPE PIC '9',
                          2 REST PIC '(12)9',
                           SAVEVOL PIC '99999',
                         TEMP PIC '99999',
                         TEMP1 PIC '9',
                        CNTR FIXED(3,0),
                          ANGEN PIC '9999' INIT(1000),
                         BNGEN PIC '9999' INIT(3000),
                          SAVEAND PIC '9999' INIT(0000),
                           TESTA PIC '9' INIT(0),
                           TESTB PIC '9' INIT(0),
                          SAVEBND PIC '99999';
   3      1             ON ENDFILE(NODEP) GO TO FIN;
   5      1             ON KEY(CNVRTK) GO TO ERMES;
   7      1              OPEN FILE(CNVRTO), FILE(NODEP), FILE(CNVRTK);
   8      1             CNVKIN.ANODE,CNVKIN.ALEG,CNVKIN.BNODE,CNVKIN.BLEG,CNVKIN.DIST,CNVKIN.SPEEDA,
                        CNVKIN.TPEN1,CNVKIN.ABCAP,CNVKIN.CONVFA,CNVKIN.AVOL,CNVKIN.MISC1,CNVKIN.SPEEDB,
                        CNVKIN.TPEN2,CNVKIN.BACAP,CNVKIN.CONVFB,CNVKIN.BVOL,CNVKIN.MISC3,CNVKIN.FCLASS,
                        CNVKIN.MISC4,CNVKIN.ATYPE,CNVKIN.REST=0;
   9      1             DUMREC.ANODE,DUMREC.ALEG,DUMREC.BNODE,DUMREC.BLEG,DUMREC.DIST,DUMREC.SPEEDA,
                        DUMREC.TPEN1,DUMREC.ABCAP,DUMREC.CONVFA,DUMREC.AVOL,DUMREC.MISC1,DUMREC.SPEEDB,
                        DUMREC.TPEN2,DUMREC.BACAP,DUMREC.CONVFB,DUMREC.BVOL,DUMREC.MISC3,DUMREC.FCLASS,
                        DUMREC.MISC4,DUMREC.ATYPE,DUMREC.REST=0;
  10      1              CNVKIN.TS1,DUMREC.TS1='S';
  11      1               CNVKIN.TS2,DUMREC.TS2=' ';
  12      1              CNVKIN.GAPO,DUMREC.GAPO=' ';
  13      1             DUMREC.SPEEDA,DUMREC.SPEEDB=10;
  14      1              DUMREC.AVOL,DUMREC.BVOL=1000;
  15      1              DUMREC.ATYPE,DUMREC.FCLASS=1;
  16      1              KEYCNT=0;
  17      1             CNTR=0;
  18      1              TEMP,TEMP1,SAVEVOL=0;
  19      1               SAVEBND=0;
  20      1              RER: READ FILE(NODEP) INTO (NDPI);
  21      1                READ FILE(CNVRTK) INTO (CNVKIN) KEY(NDPI);
  22      1              CNVKIN.ANODE=ANGEN;
  23      1              CNVKIN.BNODE=BNGEN;
  24      1                    CNVKIN.AVOL=CNVKIN.BVOL+CNVKIN.AVOL;
  25      1                      CNVKIN.BVOL=0;
  26      1              IF CNVKIN.ABCAP>= 5000 THEN CNVKIN.ABCAP=9999;
  28      1              ELSE CNVKIN.ABCAP=CNVKIN.ABCAP+CNVKIN.BACAP;
  29      1               IF CNVKIN.SPEEDA=0 THEN DO;
  31      1      1                 IF CNVKIN.ATYPE=1 THEN DO;
  33      1      2                       IF CNVKIN.FCLASS=1 THEN CNVKIN.SPEEDA=45;
  35      1      2                        ELSE CNVKIN.SPEEDA=15;
  36      1      2                        END;
  37      1      1                  IF CNVKIN.ATYPE=2 THEN DO;
  39      1      2                        IF CNVKIN.FCLASS=1 THEN CNVKIN.SPEEDA=55;
```

```
RUMMY: PROC OPTIONS(MAIN);

STMT LEVEL NEST

  41    1    2                ELSE CNVKIN.SPEEDA=25;
  42    1    2                END;
  43    1    1          IF CNVKIN.ATYPE=3 THEN DO;
  45    1    2                IF CNVKIN.FCLASS=1 THEN CNVKIN.SPEEDA=60;
  47    1    2                ELSE CNVKIN.SPEEDA=35;
  48    1    2                END;
  49    1    1    END;
  50    1         IF CNVKIN.SPEEDB=0 THEN CNVKIN.SPEEDB=10;
  52    1         IF (CNVKIN.ABCAP=0 & CNVKIN.FCLASS=1) THEN CNVKIN.ABCAP,CNVKIN.BACAP=4000;
  54    1         IF (CNVKIN.ABCAP=0 & CNVKIN.FCLASS=2) THEN CNVKIN.ABCAP,CNVKIN.BACAP=1200;
  56    1         IF (CNVKIN.ANODE=SAVEBND & CNVKIN.ALEG=TESTB) THEN DO;
  58    1    1     IF TESTB =0 THEN CNVKIN.ALEG=1;
  60    1    1     ELSE IF TESTB=1 THEN CNVKIN.ALEG=2;
  62    1    1     ELSE CNVKIN.ALEG=3;
  63    1    1     END;
  64    1         IF (CNVKIN.BNODE=SAVEBND & CNVKIN.BLEG=TESTB) THEN DO;
  66    1    1     IF TESTB =0 THEN CNVKIN.BLEG=1;
  68    1    1     ELSE IF TESTB=1 THEN CNVKIN.BLEG=2;
  70    1    1     ELSE CNVKIN.BLEG=3;
  71    1    1     END;
  72    1         IF (CNVKIN.BNODE=SAVEAND & CNVKIN.BLEG=TESTA) THEN DO;
  74    1    1     IF TESTA =0 THEN CNVKIN.BLEG=1;
  76    1    1     ELSE IF TESTA=1 THEN CNVKIN.BLEG=2;
  78    1    1     ELSE CNVKIN.BLEG=3;
  79    1    1     END;
  80    1          IF CNVKIN.ANODE=SAVEAND THEN DO;
  82    1    1       RENODE: CNVKIN.ANODE=ANGEN;
  83    1    1      ANGEN=ANGEN+2;
  84    1    1      CNTR=0;
  85    1    1        END;
  86    1          IF CNVKIN.ANODE¬=SAVEBND THEN CNTR=0;
  88    1       DUMER: IF CNTR=0 THEN DO;
  90    1    1   DUMREC.ANODE= CNVKIN.ANODE-1;
  91    1    1   DUMREC.BNODE= CNVKIN.ANODE;
  92    1    1    IF (DUMREC.ANODE=SAVEAND & DUMREC.ALEG=TESTA) THEN DO ;
  94    1    2          IF TESTA=0 THEN DUMREC.ALEG=1;
  96    1    2             ELSE IF TESTA=1 THEN DUMREC.ALEG=2;
  98    1    2        ELSE DUMREC.ALEG=3;
  99    1    2             END;
 100    1    1      IF CNVKIN.ALEG=0 THEN DUMREC.BLEG=1;
 102    1    1    IF CNVKIN.ALEG=1 THEN DUMREC.BLEG=2;
 104    1    1    IF CNVKIN.ALEG=2 THEN DUMREC.BLEG=3;
 106    1    1      IF CNVKIN.ALEG=3 THEN DO ;
 108    1    2         CNVKIN.ALEG=2;
 109    1    2       DUMREC.BLEG=3;
 110    1    2            END;
 111    1    1     DUMREC.ABCAP=CNVKIN.ABCAP;
 112    1    1    DUMREC.BACAP=CNVKIN.BACAP;
 113    1    1     IF CNVKIN.ATYPE=1 THEN DUMREC.ATYPE=1;
 115    1    1      ELSE IF CNVKIN.ATYPE=2 THEN DUMREC.ATYPE=2;
```

```
RUMMY: PROC OPTIONS(MAIN);

STMT LEVEL NEST

 117    1    1        ELSE IF CNVKIN.ATYPE=3 THEN DUMREC.ATYPE=3;
 119    1    1        IF CNVKIN.FCLASS=1 THEN DUMREC.FCLASS=1;
 121    1    1         ELSE DUMREC.FCLASS=2;
 122    1    1      DUMREC.DIST=CNVKIN.DIST;
 123    1    1        DUMREC.AVOL=CNVKIN.AVOL;
 124    1    1        DUMREC.BVOL=0;
 125    1    1        WRITE FILE(CNVRTO) FROM (DUMREC);
 126    1    1     END;
 127    1             SAVEAND=CNVKIN.ANODE;
 128    1           SAVEBND=CNVKIN.BNODE;
 129    1             TESTA=CNVKIN.ALEG;
 130    1             TESTB=CNVKIN.BLEG;
 131    1              CNVKIN.TS2=' ';
 132    1           ANGEN=ANGEN+2;
 133    1             BNGEN=BNGEN+2;
 134    1             WRITE FILE(CNVRTO) FROM  (CNVKIN);
 135    1           CNTR=CNTR+1;
 136    1             GO TO RER;
 137    1           ERMES: PUT SKIP EDIT ('*********ERROR WITH KEY ON INPUT, REFER TO PL/1 REF. P.
               315*******') (A(67));
 138    1           KEYCNT=KEYCNT+1;
 139    1            IF KEYCNT >= 15 THEN DO;
 141    1    1      PUT  SKIP (10) LIST ('HELP, KEY TROUBLE- # OF KEY CONDITIONS IS ',KEYCNT);
 142    1    1     GO TO FIN;
 143    1    1     END;
 144    1            GO TO RER;
 145    1            FIN: CLOSE FILE(MODEP), FILE(CNVRTK), FILE(CNVRTO);
 146    1            END RUMMY;
```

APPENDIX B

EXAMPLES OF DATA COLLECTION AND CODING FORMAT

NODE POINTS	LOCATION		TWO-WAY AVERAGE DAILY TRAFFIC	PEAK HOUR						DAILY AVERAGE SPEED	MORNING AVERAGE SPEED	EVENING AVERAGE SPEED	HOURLY CAPACITY PER DIRECTION	HOURLY CAPACITY PER DIRECTION	TRUCK VOLUMES	SPECIAL TOPOGRAPHY	CAPACITY ALTERATIONS	SENSITIVE LAND USES	CBD - HIGH RISE	SIGNAL PROGRESSION	FUNCTIONAL CLASS
				DIREC-TION	MAX. HR. BEGIN-ING	VOLUME	DIREC-TION	MAX. HR. BEGIN-ING	VOLUME												
	West Florissant																				
1023-1763	I-70	Kingshighway	17855	2-N	4:30PM	1786	2-S	7:00AM	1680	25	40 SB	27 NB	1200	1200							2
1763-1761	Kingshighway	Calvary								25	40 SB	27 NB	1200	1200						1	2
1761-1760	Calvary	Union								25	40 SB	25 NB	1200	1200						1	2
1760-1201	Union	Riverview	19507	2-E	7:00AM	1610	2-W	4:30PM	1751	25	40 SB	25 NB	1200	1200						1	2
1201-1260	Riverview	Goodfellow	12550	2-E	7:00AM	797	2-W	4:30PM	904	25	40 SB	25 NB	1200	1200						1	2
1260-1453	Goodfellow	Jennings Sta.	13797	2-E	7:00AM	929	2-W	4:15PM	859	25	30 SB	26 NB	1200	1200							2
1453-1451	Jennings Sta.	Lucas & Hunt	19391	2-N	4:45PM	954	2-S	7:00AM	942	29	38 SB	23 NB	1200	1200			3				2
1451-1441	Lucas & Hunt	Chambers	29293	2-N	5:00PM	1794	2-S	6:45AM	1866	29	15 SB	14 NB	1200	1200			3			2	2
1441-1079	Chambers	I-270	27170							29	16 SB	22 NB	1200	1200							2
1079-1210A	I-270	New Halls Ferry	11830							29											2
	Bermuda-Elizabeth-Old Florissant-N. Elizabeth-Washington																				
1015-1438	I-70	Chambers	9096	2-N	4:30PM	649	2-S	6:45AM	516	29	23 SB	16 NB	600	600				2			3
1438-1078	Chambers	I-270	5290	2-0	4:30PM	623				29	20 SB	15 NB	600	600							3
1078-1423	I-270	New Florissant Rd.	10649	2-0	4:30PM	1267				29	30 SB	27 NB	600	600							3
	New Florissant (N)-Hyatt St.																				
1014-1437	I-70	Chambers	31377	2-N	4:30PM	2032	2-S	7:00AM	1850	29	20 SB	15 NB	1200	1200							2
1437-1077	Chambers	I-270	29731	2-N	4:30PM	1531	2-S	7:00AM	1319	29	20 SB	22 NB	1200	1200							2
1077-1423	I-270	Washington	18660							29			1200	1200						2	2
1423-1416	Washington	St. Michael (Parker)								29			1200	1200							2
1416-1414	Parker	Lindbergh (140)	11880							29			1200	1200							2
	Carson-Scudder-Middleway																				
1013-1435	I-70	Chambers	13251	2-0	4:15PM	1371				29			600	600							2
	Carondelet-Weber																				
1040-1484	I-55	Alabama	6675	2-E	4:15PM	366	2-W	4:45PM	333	25											
	Germania-Marceau																				
1039-1483	I-55	Alabama	13504	2-E	4:30PM	681	2-W	7:00AM	720	25			1200	1200							2
1483-1246	Alabama	S. Broadway (231)	6130	2-E	6:45AM	470	2-W	3:15PM	379	25			1200	1200							2
	Loughborough																				
1038-1480	I-55	Virginia	9218	2-E	3:45PM	404	2-W	3:45PM	416	25											3

NODE POINTS	LOCATION		TWO-WAY AVERAGE DAILY TRAFFIC	PEAK HOUR						DAILY AVERAGE SPEED	MORNING AVERAGE SPEED	EVENING AVERAGE SPEED	HOURLY CAPACITY PER DIRECTION	HOURLY CAPACITY PER DIRECTION	TRUCK VOLUMES	SPECIAL TOPOGRAPHY	CAPACITY ALTERATIONS	SENSITIVE LAND USES	CBD - HIGH RISE	SIGNAL PROGRESSION	FUNCTIONAL CLASS
				DIREC-TION	MAX. HR. BEGIN-ING	VOLUME	DIREC-TION	MAX. HR. BEGIN-ING	VOLUME												
	Rt. 725																				
1101-1119	US 40	Clayton	45350	2-W	7:30AM	2866	2-S	4:15PM	2511	50	35 SB	55 NB	4,000	4,000		2	1				1
1119-1118	Clayton	Brentwood	45350							50	55 SB	55 NB	4,000	4,000		2			Yes		1
1118-1117	Brentwood	Forest Park	50770	2-N	7:30AM	3190	2-S	4:15PM	2787	50	46 SB	47 NB	4,000	4,000		2			Yes		1
1117-1116	Forest Park	Ladue	58180	2-N	4:30PM	2931	2-S	7:30AM	3077	50	46 SB	47 NB	4,000	4,000		2					1
1116-1115	Ladue	Delmar	57020	2-N	4:30PM	3218	2-S	7:30AM	3122	50	55 SB	44 NB	4,000	4,000		2					1
1115-1114	Delmar	Olive	51170	2-N	4:30PM	2455	2-S	7:30AM	2655	50	55 SB	44 NB	4,000	4,000		4					1
1114-1113	Olive	Page	32750	2-N	4:30PM	1930	2-S	7:30AM	1679	50	55 SB	26 NB	4,000	4,000		4	3				1
	I-70																				
1005-1005A	Fifth St.	Missouri River	65890	2-E	6:30AM	3579	2-W	3:45PM	3490	38	21 EB	20 WB	4,000	4,000		2	5	1	Yes		1
1005A-1005B	Missouri River	Earth City Expressway	65890	2-E	6:30AM	3579	2-W	3:45PM	3490	38	37 EB	32 WB	4,000	4,000		2	3				1
1005B-1006	Earth City Expressway	I-244	65890	2-E	6:30AM	3579	2-W	3:45PM	3490	50	51 EB	32 WB	4,000	4,000		2	1				1
1006-1007	I-244	St. Charles Rk. Rd.	56010	2-E	7:00AM	3388	2-W	3:45PM	2817	50	23 EB	16 WB	4,000	4,000							1
1007-1008	St. Charles Rk. Rd.	Lindbergh	56130	2-E	7:00AM	3416	2-W	3:30PM	3104	50			4,000	4,000		4	1				1
1008-1009	Lindbergh	Cypress	73100	2-E	7:00AM	3051	2-W	4:00PM	3329	50			4,000	4,000		4					1
1009-1010	Cypress	Lambert Airport	73100	2-E	3:45PM	3561	2-W	3:45PM	4068	50			4,000	4,000			2	6			1
1010-1011	Lambert Airport	Natural Bridge	77690	2-E	3:45PM	3201	2-W	4:15PM	3351	50			6,000	6,000							1
1011-1012	Natural Bridge	Brown	77690							50			6,000	6,000		4					1
1012-1013	Brown	Carson	77690							50			6,000	6,000		4					1
1013-1014	Carson	New Florissant (N)	77690	2-E	3:15PM	3954	2-W	3:45PM	3806	50			6,000	6,000		4		1			1
1014-1015	New Florissant (N)	Bermuda	92560	2-E	6:30AM	4500	2-W	4:00PM	4396	50	27 EB	27 WB	6,000	6,000		4					1
1015-1016	Bermuda	Lucas & Hunt (U)	96050	2-E	6:45AM	4629	2-W	4:15PM	4780	50	47 EB	37 WB	6,000	6,000		4					1
1016-1017	Lucas & Hunt (U)	Jennings Sta.	97690							50	45 EB	37 WB	6,000	6,000		4					1
1017-1018	Jennings Sta.	Goodfellow	98050	2-E	6:30AM	5571	2-W	4:15PM	5343	50	24 EB	21 WB	6,000	6,000		4					1
1018-1019	Goodfellow	67	93460	2-E	7:00AM	5722	2-W	4:15PM	5327	38	32 EB	22 WB	6,000	6,000		4		2			1
1019-1020	67	Union	92140							38	37 EB	25 WB	6,000	6,000		4					1
1020-1021	Union	Kingshighway	92140							38	43 EB	43 WB	10,000	10,000		1	1				1
1021-1022	Kingshighway	Shreve	96960	2-E	3:15PM 3-0-7AM	3884 3401	2-W	4:30PM	4247	38	36 EB	40 WB	10,000	10,000		1					1
1022-1023	Shreve	W. Florissant	96960	2-E	3:15PM 3-0-7AM	3890 3000	2-W	4:30PM	4005	38	45 EB	50 WB	10,000	10,000		1					1
1023-1024	W. Florissant	Intermediate Pt.	92260	2-E	7:00AM 3-0-7AM	3931 3046	2-W	4:30PM	3847	38		52 WB	10,000	10,000		1					1
1024-1024.1	Intermediate Pt.	Carrie	111020							38		52 WB	10,000	10,000		1					1
1024.1-1025	Carrie	Grand	107290	2-N	4:30PM 3-0-4:30PM	5360 5360	2-S	7:00AM	4941	38	32 EB	52 WB	10,000	10,000		2					1
1025-1026	Grand	Salisbury	109420	2-N	4:30PM 3-0-7AM	4909 3357	2-S	7:00AM	4699	38	28 EB	52 WB	10,000	10,000		2					1
1026-1027	Salisbury	St. Louis Ave.	102710							38	44 EB	46 WB	10,000	10,000		1					1
1027-1028	St. Louis Ave.	Cass	114490	2-N	4:15PM 3-0-7AM	4914 3465	2-S	7:15AM	4785	38	42 EB	45 WB	10,000	10,000		1					1
1028-1029	Cass	M. L. King Dr.	87740							38	42 EB	45 WB	10,000	10,000		2		2	Yes		1